ADA

U.S. ARMY FIELD DEMONSTRATION OF THE SINGLE COMMON POWERTRAIN LUBRICANT (SCPL)

INTERIM REPORT
TFLRF No. 454

by
Adam C. Brandt
Edwin A. Frame

U.S. Army TARDEC Fuels and Lubricants Research Facility
Southwest Research Institute® (SwRI®)
San Antonio, TX

for
Mr. Allen S. Comfort
U.S. Army TARDEC
Force Projection Technologies
Warren, Michigan

Contract No. W56HZV-09-C-0100 (WD17, WD21)

February 2015

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EXECUTIVE SUMMARY

The U.S. Army TARDEC Fuels & Lubricants Technology Team has developed the requirement for a Single Common Powertrain Lubricant (SCPL), designed to consolidate multiple military lubricant specifications into a single product, or single specification. This report covers the long term field demonstration programs of the SCPL conducted at Ft. Benning GA, Ft. Wainwright AK, and Ft. Bliss TX, representing basic, arctic, and desert climate conditions respectively. Goals of each field demonstration location included:

- Compare the performance of standard military lubricants (i.e., MIL-PRF-2104 OE/HDO 15W40 or MIL-PRF-46167D OEA30 where applicable) with the SCPL when operated under a normal military duty cycles.
- Conduct testing in multiple locations representative of basic, desert, and arctic climate conditions as defined by AR 70-38, to demonstrate the performance of the SCPL under diverse ambient conditions.
- Compare the performance of two separate SCPL formulations developed during laboratory testing phases [1,2,3].
- Demonstrate the SCPL as a “drop-in” replacement for current fielded petroleum, oil, and lubricant (POL) products, requiring no additional changes or vehicle maintenance to realize performance benefits.
- Quantify real world (i.e., non-laboratory) performance of the SCPL (this can include, but is not limited to: oil performance and degradation, vehicle maintenance impact, component wear protection, and overall fleet efficiency improvement).

Results from each testing location support technical findings during the development phases of the SCPL program, and demonstrate that the SCPL is a capable drop in replacement for currently utilized MIL-PRF lubricants providing equivalent to, and in most cases improved performance to currently fielded POL products. The SCPL successfully completed a minimum of 1-year operation in the arctic and desert environments, and remained in use for a full 2-years without changes in the basic climate location demonstrating the SCPL’s extended drain capabilities. All three field demonstration logged a combined 60k miles of operation using the SCPL over the

course of two years. The improved performance of the SCPL was evident through comparison of the used oil analysis which showed comparable wear protection between the two baseline products despite a substantial shift in viscosity, as well as longer drain intervals of the SCPL synthetic base stock. No perceptible performance differences were noted in any applications that would suggest compatibility issues with the SCPL. All of the above support that the SCPL is meeting or exceeding its originally intended goals, and is ready for fielding in U.S. Army equipment.

FOREWORD/ACKNOWLEDGMENTS

The U.S. Army TARDEC Fuel and Lubricants Research Facility (TFLRF) located at Southwest Research Institute (SwRI), San Antonio, Texas, performed this work during the period of June 2011 through January 2014 under Contract No. W56HZV-09-C-0100. The U.S. Army Tank Automotive RD&E Center, Force Projection Technologies, Warren, Michigan administered the project. Mr. Eric Sattler (RDTA-SIE-ES-FPT) served as the TARDEC contracting officer's technical representative. Mr. Allen Comfort of TARDEC served as project technical monitor.

The authors would like to acknowledge the contribution of the TFLRF technical and administrative support staff, as well as all support provided by personnel at Ft. Wainwright AK, Ft. Benning GA, and Ft. Bliss TX in the administering and operation of the field demonstrations.

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ACRONYMS AND ABBREVIATIONS

AD – Armored Division
AK - Alaska
AR – Army Regulation
CI – cubic inch
DOL – Directorate of Logistics
DOTS – Directorate of Training Sustainment
FORSCOM - Forces Command
FMTV – Family of Medium Tactical Vehicles
FMX – Fleet Management Expansion
FRAGO – fragmentary order
Ft. - Fort
GA - Georgia
GEP – General Engine Products
GOCO – government owned contractor operated
GSMMD – Ground Systems Material Management Directorate
HEMTT – Heavy Expanded Mobility Tactical Truck
HET – heavy equipment transporter
HMMWV – high mobility multipurpose wheeled vehicle
HP - horsepower
L – liter
MATV – MRAP All Terrain Vehicle
MIL-PRF – military performance
MRAP – Mine Resistant Ambush Protected
NWTC – Northern Warfare Training Center
OE/HDO – oil engine/heavy duty oil
OEA – oil engine arctic
POC – point of contact
POL – petroleum, oil, and lubricant
QTR - quarter
SBCT – Stryker Brigade Combat Team
SCPL – Single Common Powertrain Lubricant
SUS-V – Small Utility Support Vehicle
TACOM – Tank-Automotive and Armaments Command
TARDEC – Tank Automotive Research Development and Engineering Center
TRADOC - Training and Doctrine Command
TFLRF – TARDEC Fuels and Lubricants Research Facility
SwRI – Southwest Research Institute
TX - Texas
U.S. – United States
USARAK – U.S Army Alaska

1.0 BACKGROUND & INTRODUCTION

The U.S. Army TARDEC Fuels & Lubricants Technology Team has developed the requirement for a Single Common Powertrain Lubricant (SCPL), designed to consolidate multiple military lubricant specifications into a single product, or single specification. The application of the SCPL includes engine lubrication, power shift transmission operation, and limited use in hydraulic systems where MIL-PRF-2104 and MIL-PRF-46167 products are currently used. The SCPL is designed to operate in ambient temperatures ranging from low temperature arctic, to high temperature desert conditions, representative of the wide range of potential military operating conditions seen worldwide. The development of the SCPL allows for a single lubricant specification to be universally used in tactical and combat vehicles, despite their seasonal or geographical location, and reduces the logistics burden of the Army's supply chain through petroleum, oil, and lubricant (POL) product simplification. In addition, technological lubricant advancements of the SCPL allow for improved oil performance and vehicle efficiency over current military specified lubricants [1,2,3], all of which provide a potential cost benefit to military operations.

This report covers field demonstration programs of the SCPL, conducted at three U.S. Army installations across the United States representing basic, arctic, and desert climate conditions. These demonstrations were designed to test the technology of the SCPL in "real world" military conditions, and demonstrate the general concept of the SCPL as a multifunction single specification fluid. This report covers all efforts conducted at Ft. Benning GA from December 2011 through December 2013 (basic climate), Ft. Wainwright AK from August 2012 through September 2013 (arctic climate), and Ft. Bliss TX from January 2013 through January 2014 (desert climate). All SCPL field demonstration efforts were coordinated, monitored, and operated by the government owned, contractor operated (GOCO) U.S. Army TARDEC Fuels and Lubricants Research Facility (TFLRF), located at Southwest Research Institute (SwRI) in San Antonio, Texas.

2.0 PROGRAM OBJECTIVES

Several key factors guided the administration and design of the SCPL field demonstrations. Each demonstration was originally targeted for an operational duration of 1-year, and the administration and operation of the test was to be on a non-interference basis with participating organizations, as to not disrupt normal duty cycles and/or missions. Routine monitoring of field demonstrations would be conducted by TFLRF, and would primarily consist of quarterly site visits for general liaison, data collection, and used oil sampling. It was anticipated that additional field site visits would be scheduled on an as needed basis to ensure proper administration and support of the program, but primary management would be targeted for the pre-scheduled quarterly intervals. The objectives of each of the SCPL field demonstrations were to:

- Compare the performance of standard military lubricants (i.e., MIL-PRF-2104 OE/HDO 15W40 or MIL-PRF-46167D OEA30 where applicable) with the SCPL when operated under a normal military duty cycles.
- Conduct testing in multiple locations representative of basic, desert, and arctic climate conditions as defined by AR 70-38, to demonstrate the performance of the SCPL under diverse ambient conditions.
- Compare the performance of two separate SCPL formulations developed during laboratory testing phases [1,2,3].
- Demonstrate the SCPL as a “drop-in” replacement for current fielded POL products, requiring no additional changes or vehicle maintenance to realize performance benefits.
- Quantify real world (i.e., non-laboratory) performance of the SCPL (this can include, but is not limited to: oil performance and degradation, vehicle maintenance impact, component wear protection, and overall fleet efficiency improvement).

3.0 DETAILS OF DEMONSTRATION

3.1 GENERAL

As outlined above, multiple test sites were desired to assess performance over a wide range of climate conditions. Through a selection process that considered geographical location, resulting climate, and types of military operation and vehicles available, three test locations were selected for the SCPL field demonstration program:

- Ft. Benning GA - basic climate
- Ft. Wainwright AK - arctic climate
- Ft. Bliss TX - desert climate

Additional locations were considered during the early selection process, but these three locations were found most responsive and interested in test participation, and found best to meet the desired goals of the field demonstration. The following sections outline the general path and points of contacts that lead to the inclusion of each test location.

3.1.1 Basic Climate Condition - Ft. Benning GA

Mr. Joe Coakley, the TARDEC Logistics Management Specialist overseeing logistics planning for Ft. Benning, Ft. Rucker, and Ft. McCoy, was approached regarding SCPL testing for the basic climate condition. The test plan and goals for SCPL field demonstration were presented by TFLRF for consideration, and interest was reciprocated in participating. Upon request, a letter of intent was provided by TARDEC and TFLRF to Mr. Coakley reflecting the program plans and goals. Mr. Coakley then tasked Mr. Jim Logan, the director of FMX TACOM at Ft. Benning to coordinate the basic climate field demonstration program. Mr. Logan then identified Mr. Thomas Esposito, the Ground Systems Material Management Directorate (GSMMD) Chief, Track Division, and Mr. Allen Dimsdale, the FMX Wheeled Vehicles Directorate Chief, as the appropriate points of contact for TFLRF to plan and execute the program with.

TFLRF then began contact with Mr. Esposito and Mr. Dimsdale, and several onsite planning meetings occurred with GSMMD and FMX staff members to review the test plan, discuss the overall goals, and coordinate the vehicles and timing required to initiate testing at Ft. Benning. During this process personnel from the Directorate of Training Sustainment (DOTS) were

included, as DOTS owned and managed the equipment identified to be used in the test. This included Mt. Scott Fabozzi, Director, Mr. Joe Massouda, Support Operations Officer, Mr. Jimmy Tarrance, Supply and Services Division Chief, and Mr. Jose Hamilton, the Armor School Liaison Officer. Through continued communication, it was determined that primary TFLRF coordination for the field demonstration was to be made through DOTS, as they had the most control and oversight of the vehicles in regards to the project requirements.

Through continued coordination TFLRF and DOTS identified the vehicle fleet to be utilized in the field demonstration. Despite initial planning to evaluate two SCPL candidates at each testing location, at the time of initiation of testing at Ft. Benning only one of the SCPL candidates was readily available in bulk quantities required to support testing (herein referred to as SCPL Oil A), and as a result adjustments were made to reduce the size of the fleet from the original proposal, eventually settling on a total quantity of 35 vehicles (23 TEST, 12 CONTROL) for the fleet.

A final program briefing was held at Ft. Benning in November 2011, comprised of personnel from TARDEC, TFLRF, DOTS, vehicle maintenance, plus some end equipment users. The briefing reviewed the background and previous laboratory testing of the SCPL, and laid out the specific test plan and requirements for testing. The basic climate field demonstration was officially initiated during the weeks of December 5-16, 2011. Prior to the programs original end date in December 2012, the program was extended for an additional year to gain greater utilization of the vehicles. The field demonstration was seamlessly operated through the extension process, and finally terminated during December 2013, 24 months after its original initiation. Detailed results for this test location follow in the results section of the report.

3.1.2 Arctic Climate Condition - Ft. Wainwright AK

Contact to Ft. Wainwright AK for arctic testing of the SCPL was initially made to the Directorate of Logistics (DOL). From this inquiry Mr. Chris Wolney, USARAK G4 Chief of Operations, was identified to pursue testing in the region. Mr. Wolney was then presented with the basic outline and goals for the field demonstration for consideration, in which he included Mr. Paul Thakur, USARAK Science Advisor, and Mr. Jeremy Widener, Ft. Wainwright G4 Ground Maintenance. A request was made for a written test plan to outline the official goals and

requirements of the field demonstration, in which TFLRF responded appropriately. After some select back and forth adjustments to the test plan were completed, a commitment was made by USARAK to participate as the SCPL arctic test location. A fragmentary order (FRAGO) was then issued by the USARAK G4 which tasked 1/25 SBCT and NWTC units to provide the desired vehicles and participate in the test program. The test fleet was composed of a total of 16 vehicles, which included tactical wheeled vehicles similar to those used in the basic climate fleet, along with the specific addition of a small number of Small Unit Support Vehicles (SUS-V), a vehicle which is location specific (i.e., used only in arctic climates).

The first site visit by TFLRF to Ft. Wainwright occurred the week of August 27-31, 2012. Similar to the constraints present for the Ft. Benning field demonstration, only one of two SCPL candidate oils was available in the bulk quantities needed to setup and operate the field demo, and as a result only a single SCPL candidate was evaluated at this location (the same formulation tested at Ft. Benning, SCPL Oil A). The arctic field demonstration officially started the week of August 27-31, 2012, and was operated through the week of September 16-20, 2013, 13 months after initiation. Detailed results for this test location follow in the results section of the report.

3.1.3 Desert Climate Condition - Ft. Bliss TX

Contact for desert climate testing was first made to Mr. Jose Valverde, the Chief of Maintenance at the Ft. Bliss DOL. Mr. Valverde had previously worked with TFLRF in a past TARDEC field demonstration assessing synthetic blend fuels at Ft. Bliss. Response from the past program was positive, and TFLRF attempted to leverage this past experience to setup the SCPL demonstration. However since the previous program had been conducted, Ft. Bliss TX had restructured significantly, with only FORSCOM units now being available for test participation. This was slightly less desirable as FORSCOM units and equipment do not tend to have as long term stability in a research type environment compared to TRADOC units. Despite this, it was determined that Ft. Bliss still provided the best fulfillment of all remaining demonstration goals for the desert climate.

Mr. Valverde directed TFLRF to Mr. Michael O’Brien at the Mission Support Element G4 of the 1st Armored Division (1st AD). TFLRF staff made contact to Mr. O’Brien, who then redirected to

G4 MSE, Wanda Cobb and the G4 LTC, Corey Cook. After initial discussions with MSE Cobb and LTC Cook, TFLRF submitted a formal field demonstration request to 1-AD for participation in the program. Through a series of discussions and emails, LTC Cook agreed to participate and tasked 1-AD to coordinate the program with TFLRF. G4 Maintenance Officer CW4 William Caldwell was ultimately identified as the initial point of contact for coordinating efforts to start the program with the division.

Several meetings took place between TFLRF and various staff at the G4 level at Ft. Bliss to coordinate the program. This process took longer than expected due to obligations of the participating division, and as a result liaison on the G4 side changed hands several times. CW5 Jared McClinton and SGM Edward Peters were the final G4 contacts provided to TFLRF at the programs initiation. Based on the desired vehicle makeup for the program, 2nd Brigade of 1st AD (2-1AD) was identified as the participating unit. CW4 Arnold Moore was appointed by the G4 as the brigade POC for the effort. After planning discussions were completed with Chief Moore, a final fleet of 21 vehicles were identified for testing.

The Ft. Bliss vehicle fleet differed slightly from the other testing locations. All of the wheeled vehicles tasked for inclusion were made up solely of Mine Resistant Ambush Protected (MRAP) variants, as they were determined to be the prime wheeled vehicle movers within the division compared to that of typical tactical wheeled vehicles used at the other locations. In addition, a small number of combat and tracked vehicles were also included consistent with those used at the Ft. Benning location. Chief Moore then tasked three battalions within 2-1 AD to fulfill the desired vehicle listing: 1st Battalion, 6th Infantry Regiment (POC: CW3 Richard Morris), 1st Battalion, 35th Regiment (POC: CW2 Charles Davis), and 2-1 Special Troops Battalion (POC: CW2 Cordell Childs).

The Ft. Bliss field demonstration was officially started the week of January 11-15, 2013. At that time both SCPL candidate oils were readily available, so each group of test vehicles were split between the two SCPL formulations evenly. Testing operated from January 11-15, 2013 through January 13-17, 2014, 12 months after test initiation. Detailed results for this test location follow in the results section of the report.

3.2 SCPL FIELD DEMO OILS

Two separate SCPL formulations were desired to be evaluated in the field demonstration. As previously discussed due to lubricant availability and field demo timing issues, only one test location was actually able to evaluate both SCPL formulations. SCPL OIL A contained a mixed calcium and magnesium detergent-dispersant additive system and had a sulfated ash content of 1.17%. SCPL OIL B was formulated with a calcium additive system and had a sulfated ash content of 1.14%. Ft. Benning and Ft. Wainwright were solely operated on the SCPL OIL A formulation, while Ft. Bliss was an even split between two formulations, herein referred to as SCPL OIL A and SCPL OIL B. 0 below shows the different oil properties for each of the SCPL formulations evaluated. Previous laboratory testing showed that both formulations performed similarly in engine and transmission testing applications, and as such performance from each formulation in the field demonstration was expected to be similar.

Table 1. Field Demo SCPL Base Oil Properties

Method	Property	Units	SCPL Oil A	SCPL Oil B
D445 100c	Viscosity	cSt	8.47	8.69
D4739	Buffer	mg KOH/g	9.49	10.44
D5185	Al	ppm	2	4
	Sb	"	<1	<1
	Ba	"	<1	<1
	B	"	14	4
	Ca	"	902	3563
	Cr	"	<1	<1
	Cu	"	<1	<1
	Fe	"	1	2
	Pb	"	<1	<1
	Mg	"	1259	16
	Mn	"	<1	<1
	Mo	"	64	8
	Ni	"	<1	<1
	P	"	1079	1129
	Si	"	5	7
	Ag	"	<1	<1
	Na	"	<5	10
	Sn	"	<1	<1
	Zn	"	1265	1710
	K	"	<5	8
	Sr	"	<1	<1
	V	"	<1	<1
	Ti	"	<1	<1
	Cd	"	<1	<1
D664 Acid	Buffer	mg KOH/g	1.65	2.84
D874	Sulfated Ash	mass %	1.17	1.14

3.3 Fleet vehicle descriptions

Vehicle quantities and types for testing varied between each location. These variances in the fleet vehicle makeup primarily depended the following key factors:

- Overall balance of equipment across all locations (ensuring proper representation of Army equipment in testing)
- Combined size of all three location fleets (SCPL program cost driven)
- Presence of any location specific or unusual equipment not normally accessible at the other locations (i.e., SUS-V in arctic climate, MRAP availability in desert climate)
- The expected usage profile of equipment supplied by the POC from each location (avoiding low usage groups where possible, maximizing prime movers)

A full description of test vehicles for each test location follows.

3.3.1 Vehicle Fleet - Ft. Benning GA

The tactical and combat vehicles utilized at the Ft. Benning location were comprised of the following models and quantities:

- M88 Recovery Vehicle (M88A1 & M88A2 Hercules)
    - 2 TEST, 2 CONTROL (1 ea. M88A1 & M88A2)
- M3A3 Bradley Fighting Vehicle
    - 4 TEST, 2 CONTROL
- M997 High Mobility Multipurpose Wheeled Vehicle (HMMWV) Ambulance Variant
    - 4 TEST, 2 CONTROL
- M978A4 Heavy Expanded Mobility Tactical Truck (HEMTT) Fueler Variant
    - 4 TEST, 2 CONTROL
- M1070 Heavy Equipment Transporter (HET) Tractor
    - 1 TEST (max available, critical for inclusion due to engine type)
- M1083A1 Family of Medium Tactical Vehicles (FMTV) 5-ton Cargo Vehicle
    - 4 TEST, 2 CONTROL
- M1126 Stryker Armored Fighting Vehicle
    - 4 TEST, 2 CONTROL

These vehicles were selected as a representative core of equipment utilized by the U.S. Army. It was mandatory that the test vehicle fleet included several key high density wheeled vehicles, such as the HMMWV and FMTV. These vehicle types and their general powertrain families exist in large quantities in the Army fleet, so their compatibility and resulting performance with the SCPL was of high interest as findings could then be applied to a large quantity of other vehicles. Brief descriptions of each vehicle type is listed below. Included is specific notation on which components (i.e., engine, transmission, hydraulic systems, etc.) on each vehicle were used to evaluate the SCPL:

- M88A1 Recovery:
    - 51-ton tracked recovery vehicle used in the support of fleet repair or extrication during battlefield operations. Equipped with a 35 ton lift capable boom.
    - Powered by the AVDS-1790-2DR engine, a 1790 CI 12-cylinder twin-turbocharged air-cooled diesel engine producing approximately 750hp.
    - The SCPL was evaluated in only the engine to specific transmission fluid requirements for this equipment that were outside the scope of the SCPL specification.
- M88A2 Hercules:
    - 70-ton tracked recovery vehicle used in the support of fleet repair or extrication during battlefield operations. Equipped with a 35 ton lift capable boom. Developed to increase performance over the M88A1 to allow capability for recovering the M1 Abrams tank.
    - Powered by the AVDS-1790-8CR engine, a 1790 CI 12-cylinder twin-turbocharged air-cooled diesel engine producing approximately 1050hp.
    - Consistent with the M88A1, the SCPL was evaluated in only the engine due to specific transmission fluid requirements that were outside the scope of the SCPL specification.
- M3A3 Bradley:
    - 25-30 ton tracked armored reconnaissance vehicle used in conjunction with the M1 Abrams in battlefield operation.

  - Powered by a Cummins VTA-903 engine, a 903 CI V8 turbocharged diesel engine producing approximately 660hp.
  - Final drive provided through a HMPT-500 transmission, a three forward range hydromechanical transmission which transmits power through infinitely variable ratios depending on operator input, engine load, and vehicle speed.
  - The SCPL was evaluated in both the engine and transmission. However, only 50% of the TEST vehicles transmissions were included using the SCPL due to lubricant availability at the start of testing.

- M997 HMMWV
  - Light 4-wheel drive vehicle used primarily for personnel and light cargo transport behind front lines. Consists of many variants ranging from a 2-seater pick-up truck configuration to up-armored 5-crew support vehicles.
  - Powered by the General Engine Products (GEP) 6.2L, a naturally aspirated 378 CI V8 indirect injected diesel engine producing approximately 150hp (other variants include the 6.5L NA and 6.5L(T) engines)
  - The SCPL was evaluated in only the engine due to specific transmission fluid requirements (DEXRON) that were outside the SCPL specification.

- M978A4 HEMTT
  - 20-ton 8-wheel drive heavy transport truck used for supply and re-supply of equipment in battlefield operation. Consists of many variants ranging from tow/recovery, general cargo transport, to mobile fuel movement and supply.
  - Powered by the Caterpillar C15 engine, a 15.2L turbocharged inline 6 cylinder, direct injected engine producing approximately 500hp.
  - Final drive provided by the Allison 4500SP 5-speed automatic transmission.
  - The SCPL was evaluated in both the engine and transmission during the field demonstration. However, only 50% of the TEST vehicles transmissions were included using the SCPL due to lubricant availability at the start of testing.

- M1070 HET
  - 20-ton 8-wheel drive heavy equipment transporter tractor used in conjunction with the M1000 HET trailer to transport, deploy, and evacuate tanks, armored

personnel carriers, self propelled artillery, and other heavy vehicles and equipment.
  - Powered by the Detroit Diesel 8V92T engine, a 2-cycle V8 turbocharged direct injected diesel engine producing approximately 500hp.
  - Final drive provided by the Allison CLT-755 5-speed automatic transmission.
  - The SCPL was evaluated in both the engine and transmission during the field demonstration.
- M1083A1 FMTV
  - 5-ton capacity common chassis cargo and personnel mover used to support a wide range of military operations. Consists of multiple variants ranging from general material handling arrangements, tractor trailer configuration, personnel carriers, wrecker, and other mission specific models.
  - Powered by the Caterpillar C7 ACERT engine, a 7L inline 6 cylinder turbocharged direct injected diesel engine producing approximately 350hp.
  - Final drive provided by the Allison MD3070PT 7-speed automatic transmission.
  - The SCPL was evaluated in both the engine and transmission during the field demonstration. However, only 50% of the TEST vehicles transmissions were included using the SCPL due to lubricant availability at the start of testing.
- M1126 Stryker
  - 16-ton 8-wheel drive armored fighting vehicle used in a wide range of support and battlefield operations.
  - Powered by the Caterpillar 3126 engine, an inline 6-cylinder turbocharged direct injected diesel engine producing approximately 350hp.
  - The SCPL was evaluated in only the engine due to specific transmission fluid requirements that were outside the SCPL specification.

3.3.2 Vehicle Fleet – Ft. Wainwright AK

The arctic climate fleet size was smaller in comparison to the basic and desert climate locations. This was due partly to the increased cost of operations in Alaska, as well as consideration of the more “known” performance of the SCPL in cold climate conditions. SCPL development was based off of proven low viscosity arctic type oil technology, thus it was expected to perform well

under these conditions. The fleet tactical and combat vehicles utilized at the Ft. Wainwright location was comprised of the following models:

- M997 High Mobility Multipurpose Wheeled Vehicle (HMMWV) Ambulance Variant
  - 2 TEST, 2 CONTROL
- M1120A4 Heavy Expanded Mobility Tactical Truck (HEMTT) Fueler Variant
  - 2 TEST, 2 CONTROL
- M1083A1 Family of Medium Tactical Vehicles (FMTV) 5-ton Cargo Vehicle
  - 2 TEST, 2 CONTROL
- M973A1 Small Unit Support Vehicle (SUS-V)
  - 2 TEST, 2 CONTROL

The first three vehicle types were again representative of typical high density wheeled vehicles, and overlapped those used in the basic climate demonstration for comparison purposes. The SUS-V was included as a location specific vehicle, which is only utilized in cold climate conditions were travel in heavy snow is required. A brief vehicle description is listed below for each vehicle type, including notation of which components where were used to evaluate the SCPL:

- M997 HMMWV
  - Light 4-wheel drive vehicle used primarily for personnel and light cargo transport behind front lines. Consists of many variants ranging from a 2-seater pick-up truck configuration to up-armored 5-crew support vehicles.
  - Powered by the General Engine Products (GEP) 6.2L, a naturally aspirated 378 CI V8 indirect injected diesel engine producing approximately 150hp.
  - The SCPL was evaluated in the engine, transmission, transfer case, and power steering consistent with the universal application of the MIL-PRF-46167 arctic oil in this region.
- M1120A4 HEMTT
  - 20-ton 8-wheel drive heavy transport truck used for supply and re-supply of necessary equipment in battlefield operation. Consists of many variants ranging from tow/recovery, general cargo transport, to mobile fuel movement and supply.

    - Powered by the Caterpillar C15 engine, a 15.2L turbocharged inline 6 cylinder, direct injected engine producing approximately 500hp.
    - Final drive provided by the Allison 4500SP 5-speed automatic transmission.
    - The SCPL was evaluated in the engine, transmission, transfer case, and power steering consistent with the universal application of the MIL-PRF-46167 arctic oil in this region.

- M1083A1 FMTV
    - 5-ton capacity common chassis cargo and personnel mover used to support a wide range of military operations. Consists of multiple variants ranging from general material handling, tractor trailer configuration, personnel carriers, wrecker, and other mission specific models.
    - Powered by the Caterpillar C7 ACERT engine, a 7L inline 6 cylinder turbocharged direct injected diesel engine producing approximately 350hp.
    - Final drive provided by the Allison MD3070PT 7-speed automatic transmission.
    - The SCPL was evaluated in the engine, transmission, transfer case, and power steering consistent with the universal application of the MIL-PRF-46167 arctic oil in this region.

- M973A1 SUS-V
    - 5-ton amphibious all terrain articulated tracked vehicle designed to carry troops and equipment through heavy snow and bog lands. Consists of two units with four powered tracks, capable of carrying a maximum of 17 troops (6 in the front compartment, 11 in the rear) at full capacity.
    - Powered by the Mercedes-Benz OM 603.950 engine, a 2.9L inline 6 cylinder diesel engine that produces approximately 135hp.
    - The SCPL was evaluated in the engine and power steering consistent with the universal application of the MIL-PRF-46167 arctic oil in this region. Note, the transmission was not included due to the requirement of powerpack removal to service and replace fluid.

3.3.3 Vehicle Fleet – Ft. Bliss TX

The desert vehicle fleet utilized in testing departed from the traditional wheeled vehicles used in the other two locations. This was done solely due to the low projected utilization rates of these vehicle types at this testing location, and the desire to incorporate the newer Mine Resistant Ambush Protected (MRAP) vehicles used extensively in desert type combat training. The following outlines the vehicle types and quantities utilized in the desert field demonstration location:

- M88A2 Hercules Recovery Vehicle
  - 2 TEST, 2 CONTROL
- M3A3 Bradley Fighting Vehicle
  - 4 TEST, 2 CONTROL
- MRAP All Terrain Vehicle (M-ATV)
  - 6 TEST, 2 CONTROL
- M1235A1 MaxxPro MRAP (Ambulance)
  - 2 TEST, 1 CONTROL

A brief vehicle description is listed below for each vehicle type, including notation of which components were used to evaluate the SCPL:

- M88A2 Hercules:
  - 70-ton tracked recovery vehicle used in the support of fleet repair or extrication during battlefield operations. Equipped with a 35 ton lift capable boom. Developed to increase performance over the M88A1 to allow capability for recovering the M1 Abrams tank.
  - Powered by the AVDS-1790-8CR engine, a 1790 CI 12-cylinder twin-turbocharged air-cooled diesel engine producing approximately 1050hp.
  - The SCPL was only evaluated in the engine due to specific transmission fluid requirements that were outside the scope of the SCPL specification.
- M3A3 Bradley:
  - 25-30 ton tracked armored reconnaissance vehicle used in conjunction with the M1 Abrams in battlefield operation.

    - Powered by a Cummins VTA-903 engine, a 903 CI V8 turbocharged diesel engine producing approximately 660hp.
    - Final drive provided through a HMPT-500 transmission, a three forward range hydromechanical transmission which transmits power through infinitely variable ratios depending on operator input, engine load, and vehicle speed.
    - The SCPL was evaluated in both the engine and transmission.

- Oshkosh M-ATV
    - 14-ton MRAP vehicle designed to provide the same protection of larger MRAP variants, but with improved mobility targeted at replacing the duty cycle of smaller HMMWV type vehicles.
    - Powered by the Caterpillar C7 ACERT engine, a 7L inline 6 cylinder turbocharged direct injected diesel engine producing approximately 350hp.
    - The SCPL was only evaluated in the engine, as substantial underbelly armor prevented servicing the transmission without requiring significant manpower or vehicle downtime. (Note: the transmission utilized in the M-ATV is an Allison 3500SP unit. This transmission family is well represented in other military vehicles included in this program)

- International MaxxPro MRAP
    - 14 to 16 ton (depending on category) full sized MRAP vehicle developed as an armored fighting vehicle capable of withstanding blasts from land mines or IED's through the use of a v-shaped hull. Consists of multiple variants with differing crew capabilities and end missions to support battlefield operations.
    - Powered by the International DT-570 engine, an inline 6 cylinder 570 cubic inch direct injected turbocharged diesel engine producing approximately 330hp.
    - As with the M-ATV, the SCPL was only evaluated in the engine as substantial underbelly armor preventing transmission servicing without significant manpower or vehicle downtime. (Note: the transmission utilized in the MaxxPro was an Allison 3000 series unit. This transmission family is well represented in other military vehicles included in this program)

3.4 VEHICLE PREPARATIONS

Prior to starting each field demonstration, each vehicle of the respective test fleets underwent preparation and inspections tasks to ensure quality of testing. The following vehicle preparations were completed on both test and control vehicles during the test initiation and changeover process at the start of each demonstration:

Test Vehicles:

- A thorough visual inspection was completed to ensure that engine and transmission components were not leaking fluids. Any equipment showing signs of previous leaks were notated on inspection forms, and any large leaks were corrected as required.
- A transmission stall test was performed on each test vehicle to ensure that the power pack was functioning satisfactorily.
- Prior to draining the used MIL-PRF-2104 15W-40 or MIL-PRF-46167 OEA-30 from the test vehicles, oil pressure readings were recorded at idle rpm and approximately 1,500 rpm, and an “as found” oil sample was obtained for analysis.
- Selected test vehicle components were drained and recharged with the new test SCPL. Vehicles were operated to set fluid levels and an initial oil sample was pulled for starting oil condition analysis.
- Test vehicles were tagged in operators cabins, on fluid level dipsticks, and component fill points with tags noting “TEST LUBRICANT ONLY.”
- Where possible, a 1-gallon container of make-up TEST oil was secured and stored in the operator cabin (some locations opted out of this in favor of all make-up oil going into POL areas)
- Instructions were given to preclude the components using the TEST lubricant from normally scheduled annual service lubricant changes, as oil life was being monitored by TFLRF over the duration of the program.

Control Vehicles:

- Control vehicles underwent a thorough visual inspection to insure that engines and transmissions were not leaking fluids.
- Engine and transmission levels were checked on each vehicle.
- A transmission stall test was performed on each control vehicle to insure that the power pack was performing satisfactorily.
- An “as found” used oil sample was obtained from for starting analysis.
- Control vehicles were instructed to continue operating with the designated MIL-PRF-2104 15W-40 or MIL-PRF-46167 OEA-30 oils, and remain on their normal oil change schedules.

3.5 DATA COLLECTION

The field demonstrations were designed to operate as a non-interference activity for participating organizations. As such limited data collection was conducted to accomplish this low impact factor. The general data desired from all locations is listed below.

- Total miles and hours of operation of test and control vehicles (collected by TFLRF)
- Routine oil samples on all test vehicles and selected control vehicles (collected by TFLRF)
- Total fuel added to both test and control vehicles (provided by organizations)
- Total oil added to both test and control vehicles (provided by organizations)
- Maintenance actions performed on test and control vehicles specifically impacted by the use of the non-standard oil (provided by organizations)

4.0 RESULTS

Results of the field demonstration are broken down by location and reported below. Topics covered for each test site include an overview of vehicle utilization, results and observations of the routine used oil analysis, and description of any problem areas observed with the test site or data. Note – In all tabular used oil analysis tables, any oil changes conducted are indicated by a bold vertical line between data columns. This was done to highlight any oil changes completed, whether they were required or not.

4.1 BASIC CLIMATE – FT. BENNING GA

For the basic climate location, a total fleet of 35 vehicles were identified and included into the field demonstration. The 35 vehicle fleet consisted of 23 TEST vehicles using the SCPL, and 12 CONTROL vehicles utilizing their normal POL products. Table 2 outlines the Ft. Benning fleet indicating vehicle type, description, model number, TEST/CONTROL designation, and its identification (bumper) number (Note, all used oil analysis refers to the vehicle bumper numbers for identification).

Table 2. Ft. Benning Basic Climate Vehicle Fleet

Vehicle Type	Description	Model	TEST/CONTROL	Bumper No.
M88	Tracked Recovery Vehicle	M88A1	TEST	REC8
			CONTROL	REC9
		M88A2	TEST	GMD7
			CONTROL	GMD8
Bradley	Armored Fighting Vehicle (Tracked)	M3A3	TEST	LT313
			TEST	LT314
			TEST	LT315*
			TEST	LT316*
			CONTROL	LT317
			CONTROL	LT318
HMMWV	Truck Ambulance	M997	TEST	LW024
			TEST	LW026
			TEST	LW027
			TEST	LW028
			CONTROL	LW394
			CONTROL	LW395
HEMMT	Fueler/Tanker	M978A4	TEST	HW334
			TEST	HW336
			TEST	HW337*
			TEST	HW338*
			CONTROL	HW360
			CONTROL	HW361
HET	Truck Tractor	M1070	TEST	HW127*
MTV	Truck Cargo	M1083A1	TEST	HW289
			TEST	HW290
			TEST	HW291*
			TEST	HW301*
			CONTROL	HW302
			CONTROL	HW303
Stryker	Armored Fighting Vehicle (Wheeled)	M1126	TEST	B52
			TEST	B53
			TEST	B54
			TEST	B55
			CONTROL	B57
			CONTROL	B56
* Denotes vehicles transmission included in SCPL evaluation				

4.1.1 Problem Areas – Ft. Benning

Some problem areas were observed over the test duration that impacted the collected results. These primarily revolved around the Army Oil Analysis Program (AOAP), and documentation of oil and fuel consumption by the vehicle fleet.

In regards to used oil analysis tracking, in general it was found that wheeled vehicles were overall easier to control across the test duration, as oil changes only occurred during an annual service which was more easily identified and skipped as required with using the SCPL. Tracked vehicles on the other hand follow AOAP analysis to direct oil changes as required. This proved to be more difficult to control for the SCPL demonstration than anticipated. Prior to the test initiation, TFLRF coordinated with the AOAP program office to support used oil analysis using the SCPL oil formulations, but ultimately administrative issues at the maintenance level with handling AOAP samples alongside of the normal MIL-PRF-2104 15W40 samples caused significant problems in the analysis. As a result, several of the tracked vehicles received oil changes that were not required when SCPL samples were submitted and erroneously identified as MIL-PRF-2104 15W40 instead of the correct SCPL. Lab analysis results would immediately flag the composition and viscosity difference in the TEST sample and call for an oil and filter change assuming contamination had occurred. In addition, TFLRF noted multiple instances in review of AOAP data of samples being obviously pulled from incorrect vehicles or components (i.e., elements typical in transmission samples showing in engine samples and vice versa, significant outliers in results that were not present during a resample). Several attempts were made to correct these issues over the course of the test, but in the end results were less than desired in most cases. Over the course of the test, a total of four unnecessary oil changes were conducted on various tracked vehicles in the Ft. Benning fleet. Although this did effect the ability to demonstrate the longer drain intervals of the SCPL in these vehicles, the program still demonstrated the compatibility of the low viscosity SCPL in the field environment specific to tracked vehicles.

Oil and fuel consumption data also ended up being inconclusive across testing. There were no preexisting procedures in place at Ft. Benning that would normally track oil consumption other than bulk volumes consumed, and with the varying end users of the equipment involved in the armor school, no one group of operators could be tasked with tracking oil additions for any specific piece of equipment. This prevented TFLRF from collecting specific oil consumption information by individual vehicle. Bulk oil consumption information was considered to offer little benefit to the program, as there was no apparent way to separate normal vehicle consumption versus those quantities used in oil changes (for both TEST and CONTROL

vehicles), and no way to segregate the bulk consumption for CONTROL vehicles apart from the entire DOTS fleet. Likewise for fuel usage, fuel consumption by specific vehicle was also ultimately unable to be determined. Bulk fuel logs for the multiple fueling locations used by the armor school fleet vehicles were captured for the first four quarters of the test program, but upon review, many cases of vehicle identification issues, or non-specific fuel volume information prevented any detailed analysis (i.e., several logs included a single notation of fuel added to a group of multiple vehicles, with no way to determine quantities fueled in each individual vehicle). As a result, fuel consumption data for the 5^{th}-8^{th} QTRs of the program was no longer even attempted. With the poor data available from the field, it was ultimately determined that specific oil and fuel consumption results in regards to the SCPL would better served by the laboratory testing conducted in the SCPL development phases of the program [1,2,3], where conditions were controlled tightly enough to determine actual changes in consumption/usage between SCPL and baseline testing.

4.1.2 Mileage Accumulation

Overall mileage accumulation of by each vehicle type is shown graphically in the following plots. For all plots the solid blue lines represent the TEST vehicle mileage, dashed blue lines represent the CONTROL vehicle mileage, and red dashed line represents the average mileage for the vehicle type as a whole. Full tabular mileage recordings for all vehicles are presented in the appendix, and include by quarter the mileage recordings, quarterly accumulation, and total accumulation.

In general, TEST versus CONTROL vehicle mileage for the Ft. Benning fleet was comparable, apart from a few outliers (ex: Stryker B56). Utilization in the 1-4^{th} QTR's was lower than that seen in the 5-8^{th} QTR's. This was attributed to the recent move of the armor school to Ft. Benning from its previous location at Ft. Knox KY. The SCPL field demonstration was initiated with operations at Ft. Benning being less than a year old, thus activity was still ramping up to their overall normal optempo. This was also in-part the reason for the field demo extension at this location for a full two years, to gain better utilization of the already ongoing field program.

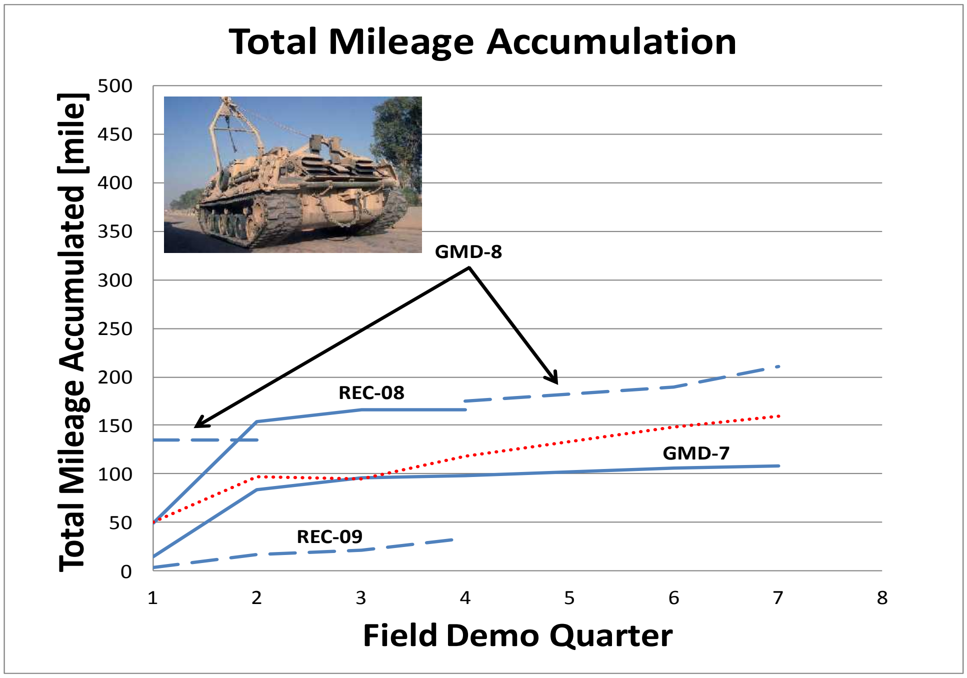

Figure 1. Ft. Benning, M88A1/A2 Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

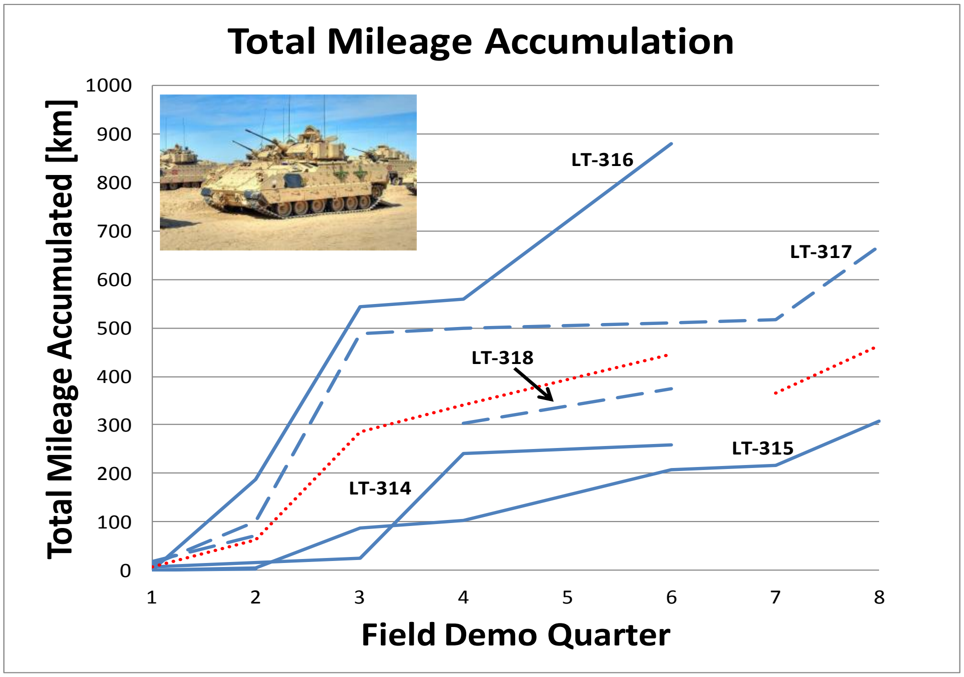

Figure 2. Ft. Benning, Bradley Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

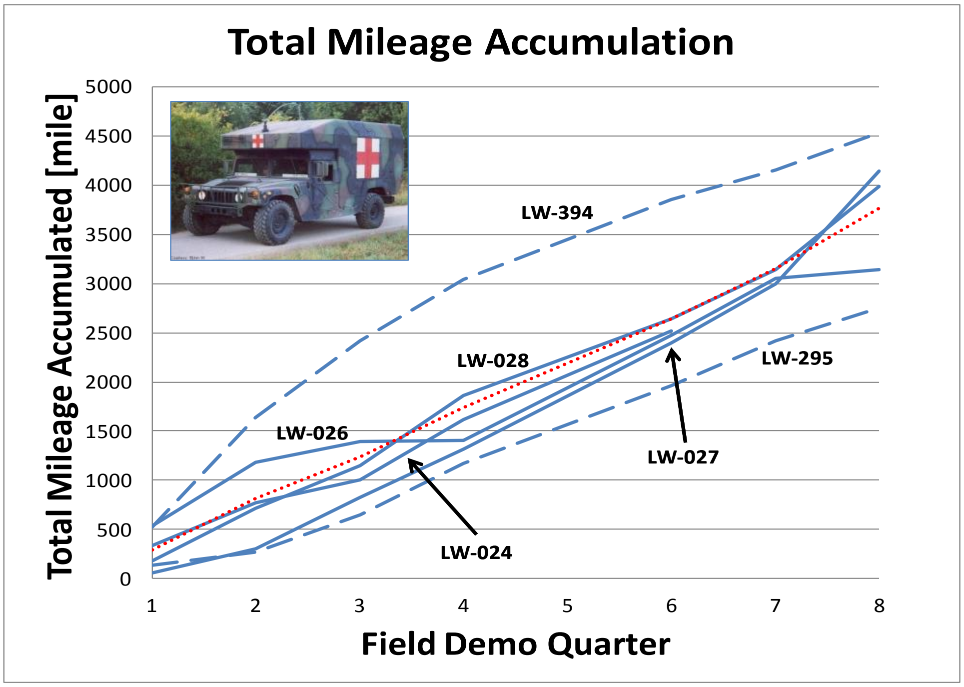

Figure 3. Ft. Benning, HMMWV Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

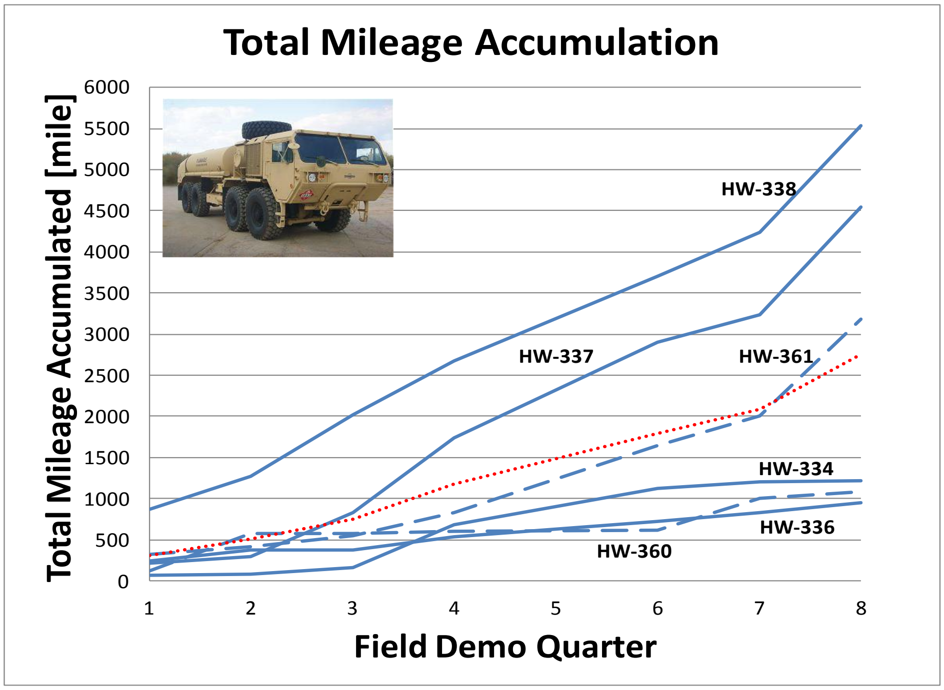

Figure 4. Ft. Benning, HEMTT Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

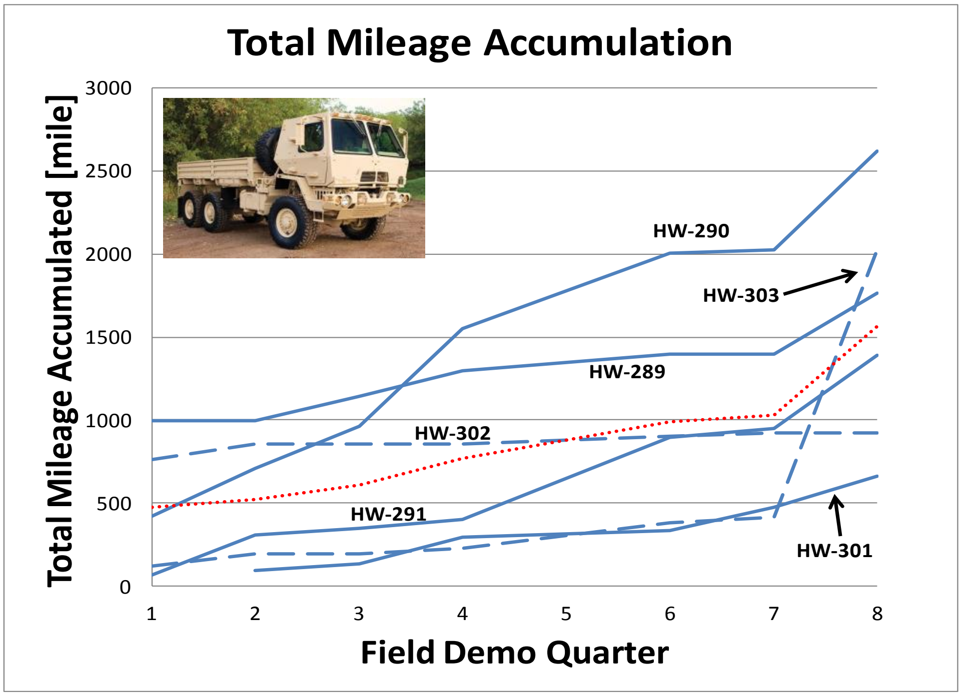

Figure 5. Ft. Benning, MTV Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

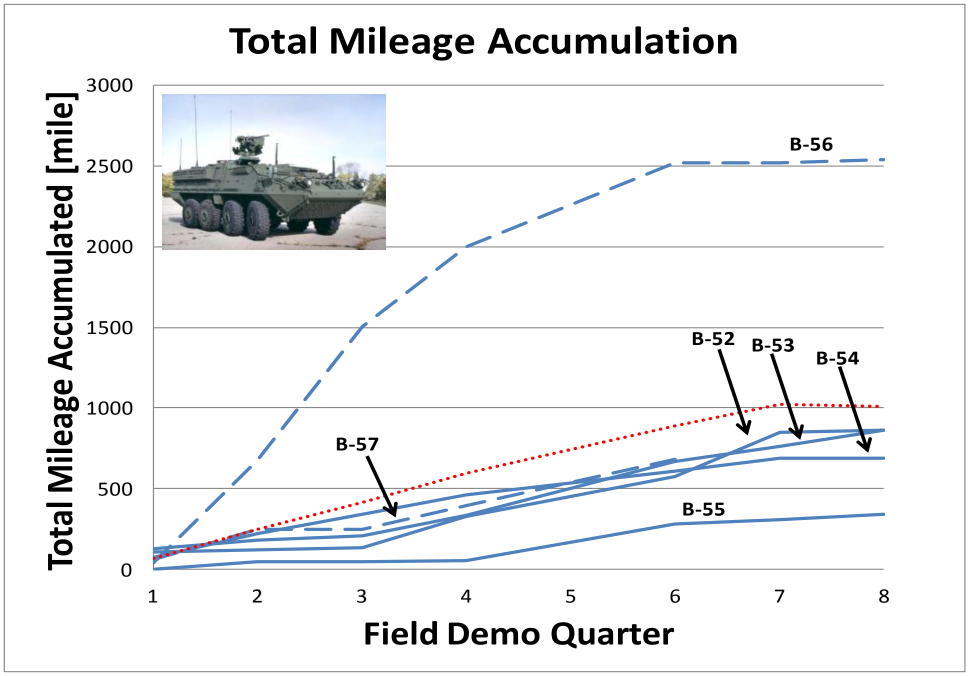

Figure 6. Ft. Benning, Stryker Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

4.1.3 Oil Analysis

Used oil analysis conducted on quarterly samples is reported below, and is broken up by vehicle type. Comments and observations made from the data are listed in a bulleted format.

<u>M88A1/A2 (engine)</u>

- All M88A1s off test after 4th QTR, as vehicles were turned in for rebuild.
- 8th QTR samples unavailable for M88A2's, as engine oil was drained and disposed of by unit personnel prior to TFLRF capturing EOT sample during the 8th QTR site visit.
- GMD7 (TEST) received unnecessary oil change between 2nd & 3rd QTR due to incorrect AOAP sample identification issue.
- REC08 (TEST) received necessary oil change between 1st & 2nd QTR due to high silicon (Si) accumulation. Silicon accumulation was attributed to dirt ingestion, which is not uncommon for this vehicle type. The "as found" sample revealed similarly high silicon levels, which suggest that a pre-existing fault in the air filtration system of this unit existed.
- Iron accumulation rates (i.e., slope not magnitude) between TEST and CONTROL were found to be similar (see Figure 7). This suggests that the SCPL is providing comparable wear protection to the baseline MIL-PRF-2104 15W40 products.
- REC09 (CONTROL) showed high copper (Cu) levels at 4th QTR immediately following a lubricant change. The source is unknown, and the unit was removed from testing before determining if the condition was persistent.
- No other significant source of wear metals were identified in the M88A1/A2 vehicles that would suggest an incompatibility with the SCPL.

Table 3. Ft. Benning UOA, M88A1/A2 Engine, TEST

TEST Engine			M88A2 - GMD7								
			Miles	531	545.5	614.9	626.8	629.4	637.1	638.9	-
			Accum.	-	14.5	83.9	95.8	98.4	106.1	107.9	-
			Hours	183	198.8	212.87	215.06	216.24	220.56	222.23	-
			Accum.	-	15.8	29.87	32.06	33.24	37.56	39.23	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		84.0%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	13.46	9.27	9.03	9.42	8.78	8.66	8.47	8.44	No Sample Available
D445 40c	Viscosity	cSt									
D2270	Viscosity Index										
D4739	TBN Buffer	mg KOH/g		9.35	9.05	8.06	9.09	8.56	8.35	8.78	
D5185	Al	ppm	5	2	6	9	4	4	4	5	
	Cu	ppm	5	1	4	10	3	4	5	5	
	Fe	ppm	20	6	34	46	17	18	25	25	
	Pb	ppm	2	<1	2	3	<1	<1	<1	1	
	Si	ppm	61	19	46	75	27	29	34	36	
D664 Acid	TAN Buffer	mg KOH/g		1.92	1.65	1.93	1.76	1.78	1.86	1.4	

TEST Engine			M88A1 - REC8								
			Miles	294	342.6	447.5	460	460	-	-	-
			Accum.	-	48.6	153.5	166	166	-	-	-
			Hours	70.5	78.8	1.76	3.71	4.49	-	-	-
			Accum.	-	8.3	-	1.95	0.78	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		81.5%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	13.87	9.47	9.38	8.6	8.78	8.72	No Longer On Test		
D445 40c	Viscosity	cSt									
D2270	Viscosity Index										
D4739	TBN Buffer	mg KOH/g		9.33	9.13	9.27	9.07	8.56			
D5185	Al	ppm	4	2	5	7	7	8			
	Cu	ppm	13	3	8	5	6	7			
	Fe	ppm	15	5	18	14	17	18			
	Pb	ppm	6	1	4	2	2	2			
	Si	ppm	119	34	128	60	70	71			
D664 Acid	TAN Buffer	mg KOH/g		2	1.9	1.79	1.69	1.62			

Note: Bold vertical lines in between data columns indicate an oil change

Table 4. Ft. Benning UOA, M88A1/A2 Engine, CONTROL

CONTROL Engine			M88A2 - GMD8								
			Miles	-	455.1	455.4	-	495.2	509.4	530.2	-
			Accum.	-	-	0.3	-	40.1	54.3	75.1	-
			Hours	-	74.08	74.08	-	85.29	91.04	94.5	-
			Accum.	-	-	0	-	11.21	16.96	20.42	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units									
D445 100c	Viscosity	cSt			12.26	12.06	12.28	12.39	12.21	12.57	No Sample Available
D445 40c	Viscosity	cSt									
D2270	Viscosity Index										
D4739	TBN Buffer	mg KOH/g			7.27	5.66	6.86	6.17	5.48	5.53	
D5185	Al	ppm			14	13	14	11	16	15	
	Cu	ppm			12	12	13	13	14	15	
	Fe	ppm			70	59	66	51	67	72	
	Pb	ppm			4	4	3	3	3	4	
	Si	ppm			25	24	26	22	27	26	
D664 Acid	TAN Buffer	mg KOH/g			2.53	2.25	2.23	2.72	2.47	2.83	

CONTROL Engine			M88A1 - REC9								
			Miles	719	722.5	736.2	740	752	-	-	-
			Accum.	-	3.5	17.2	21	33	-	-	-
			Hours	Hour Meter Inoperable					-	-	-
			Accum.						-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units									
D445 100c	Viscosity	cSt		13.23	13.02	13	13.06	14.37	No Longer On Test		
D445 40c	Viscosity	cSt									
D2270	Viscosity Index										
D4739	TBN Buffer	mg KOH/g		5.97	6.52	6.6	6.07	7.33			
D5185	Al	ppm		12	14	15	13	5			
	Cu	ppm		24	24	25	25	108			
	Fe	ppm		69	96	98	90	5			
	Pb	ppm		7	8	8	8	7			
	Si	ppm		80	83	84	82	9			
D664 Acid	TAN Buffer	mg KOH/g		2.47	2.63	2.29	2.2	1.82			

Note: Bold vertical lines in between data columns indicate an oil change

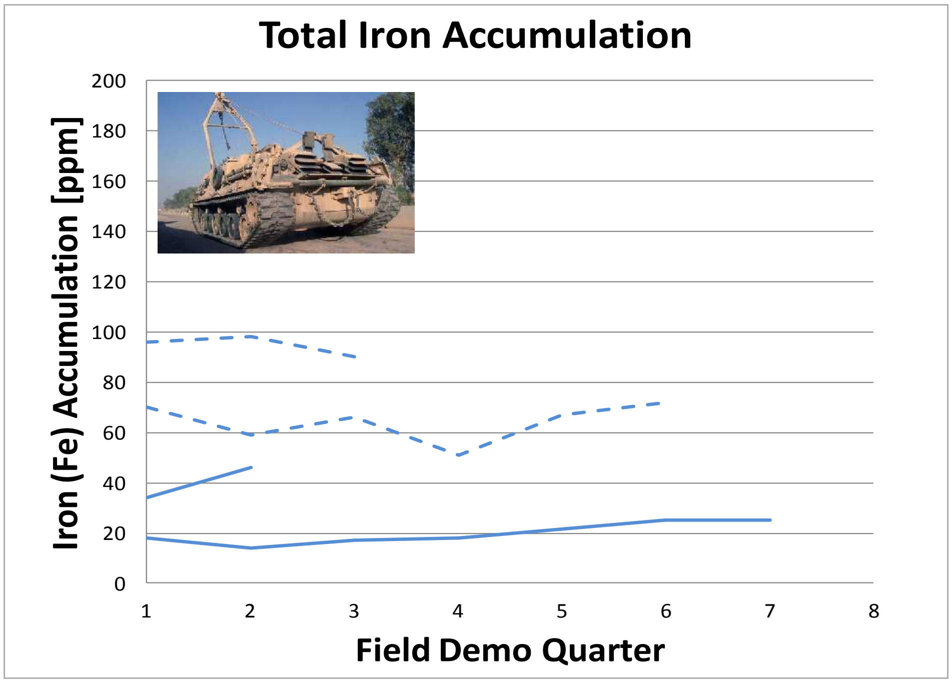

Figure 7. Ft. Benning UOA, M88A1/A2 Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

<u>Bradley (engine)</u>

- LT313 (TEST) was immediately removed from testing, as unit became a static display for classroom instruction. No appreciable usage on this vehicle was conducted with the SCPL, so no results are reported.
- LT314 (TEST) and LT316 (TEST) off test after 6th QTR due to vehicles being turned in.
- LT314 (TEST) received unnecessary oil change between 1st & 2nd QTR due to incorrect AOAP sample identification.
- LT315 (TEST) received unnecessary oil change between 3rd and 4th QTR due to incorrect AOAP sample identification.
- LT314 (TEST) showed copper accumulation in “as found” sample. Accumulation did not reoccur with use of the SCPL. The original source is unknown.
- Iron accumulation rates between TEST and CONTROL found to be similar (see Figure 8), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- No other significant source of wear metals were identified in the Bradley vehicles that would suggest an incompatibility with the SCPL.

Table 5. Ft. Benning UOA, Bradley Engine, TEST

TEST Engine — BRADLEY - LT314

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Km	723	731	739	747	964	982	-	-
			Accum.	-	8	16	24	241	259	-	-
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				83.2%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	13.11	9.25	9.29	8.72	9.41	8.77	8.25	No Longer On Test	
D445 40c	Viscosity	cSt									
D2270	Viscosity Index										
D4739	TBN Buffer	mg KOH/g		8.32	8.38	9.21	8.94				
D5185	Al	ppm	3	2	2	2	1	2	2		
	Cu	ppm	62	14	17	8	6	13	15		
	Fe	ppm	29	7	10	5	6	12	20		
	Pb	ppm	7	1	2	1	3	2	2		
	Si	ppm	11	6	8	5	6	5	6		
D664 Acid	TAN Buffer	mg KOH/g		1.94	2.14	1.71	1.67				

TEST Engine — BRADLEY - LT315

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Km	612	613	617	700	714	720	828	919
			Accum.	-	1	5	88	102	108	216	307
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				74.6%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	13.62	9.78	9.56	9.42	9.58	9.37	9.21	9.15	9.32
D445 40c	Viscosity	cSt		56.06							53.13
D2270	Viscosity Index			161							159
D4739	TBN Buffer	mg KOH/g		9.06	9.37	9.17	8.32	8.33	8.09	8.37	7.64
D5185	Al	ppm	1	1	2	2	2	2	1	2	2
	Cu	ppm	10	3	3	4	8	7	8	11	12
	Fe	ppm	10	4	4	4	15	6	7	10	10
	Pb	ppm	3	<1	1	1	5	3	3	4	5
	Si	ppm	8	6	6	5	7	6	7	8	7
D664 Acid	TAN Buffer	mg KOH/g		1.97	1.89	1.85	1.89	1.91	1.97	1.63	2.15

TEST Engine — BRADLEY - LT316

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Km	847	848	1391	-	1407	1726	-	-
			Accum.	-	1	544	-	560	879	-	-
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				78.5%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	13.45	9.54	9.38	9.53	No Sample Available	9.66	9.55	No Longer On Test	
D445 40c	Viscosity	cSt		54.57					56.72		
D2270	Viscosity Index			160					152		
D4739	TBN Buffer	mg KOH/g		8.95	9.03	8.84		7.57	6.99		
D5185	Al	ppm	2	1	2	2		2	2		
	Cu	ppm	12	3	3	5		8	11		
	Fe	ppm	16	5	5	10		16	22		
	Pb	ppm	6	<1	3	3		5	7		
	Si	ppm	9	6	5	7		7	9		
D664 Acid	TAN Buffer	mg KOH/g		1.93	1.87	1.89		2.07	2.23		

Note: Bold vertical lines in between data columns indicate an oil change

Table 6. Ft. Benning UOA, Bradley Engine, CONTROL

CONTROL Engine — BRADLEY - LT317

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Km	404	416	504	892	904	914	921	1072
			Accum.	-	12	100	488	500	510	517	668
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
D445 100c	Viscosity	cSt		14.14	13.82	13.37	13.5	13.41	13.21	13.18	13.24
D445 40c	Viscosity	cSt		103.88							96.13
D2270	Viscosity Index			138							137
D4739	TBN Buffer	mg KOH/g		7	7.93	7.35	7.01	6.32	6.27	6.18	5.83
D5185	Al	ppm		1	1	1	2	2	2	2	2
	Cu	ppm		10	10	12	17	18	21	24	25
	Fe	ppm		7	8	10	15	13	15	16	19
	Pb	ppm		1	2	2	3	2	2	3	3
	Si	ppm		6	6	6	6	6	6	7	6
D664 Acid	TAN Buffer	mg KOH/g		2.03	2.01	1.93	2	2.22	2.14	2.23	2.29

CONTROL Engine — BRADLEY - LT318

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Km	1037	1055	1108	-	1340	1411	-	1455
			Accum.	-	18	71	-	303	374	-	418
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
D445 100c	Viscosity	cSt		12.44	12.42	12.35	No Sample Available	12.35	12.42	No Sample Available	12.27
D445 40c	Viscosity	cSt		88.74							86.8
D2270	Viscosity Index			136							136
D4739	TBN Buffer	mg KOH/g		5.73	7.04	6.05		5.37	5.53		4.96
D5185	Al	ppm		2	2	2		3	3		3
	Cu	ppm		16	16	18		22	24		28
	Fe	ppm		19	19	20		23	24		30
	Pb	ppm		6	7	7		7	6		9
	Si	ppm		6	7	7		7	7		7
D664 Acid	TAN Buffer	mg KOH/g		2.55	2.43	2.66		2.78	2.57		2.46

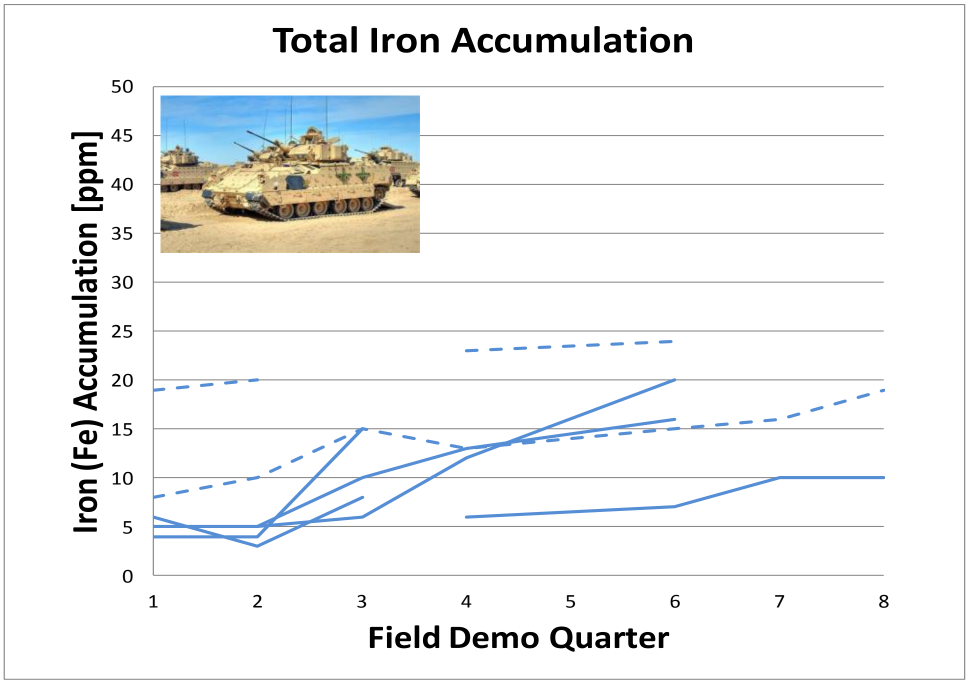

Figure 8. Ft. Benning UOA, Bradley Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

Bradley (transmission)

- No CONTROL transmission samples were acquired at Ft. Benning.
- Wear metal analysis does not show any significant accumulation of iron (Fe), lead (Pb), or copper (Cu) that would suggest excessive wear of internal components. All results observed were within established AOAP wear metal limits for this transmission model.
- Some minor cadmium (Cd) did appear in the transmission sample.
    - As will be shown in UOA from Ft. Bliss, both TEST and CONTROL transmissions tend to generate small Cd accumulation with usage.
    - The source Cd is unknown, but levels in Ft. Benning transmissions are in line with that seen in Ft. Bliss units (both TEST and CONTROL), and thus are considered typical for the component.
    - It is expected that Cd is likely a component of an internal part coating that wears under normal usage.

Table 7. Ft. Benning UOA, Bradley Transmission, TEST

TEST Trans.			BRADLEY - LT315									BRADLEY - LT316								
			Km	612	613	617	700	714	720	828	919	Km	847	848	1391	-	1407	1726	-	-
			Accum.	-	1	5	88	102	108	216	307	Accum.	-	1	544	-	560	879	-	-
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	**Property**	**Units**		88.9%	% initial changeover (calculated from vis)								84.6%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.88	8.96	8.99	8.98	9.02	8.85	8.62	8.72	8.58	12.89	9.15	9.05	8.95	No Sample Available	8.71	8.33	No Longer On Test	
D445 40c	Viscosity	cSt		49.62						48.91			50.4					48.05		
D2270	Viscosity Index			163						158			165					149		
D4739	TBN Buffer	mg KOH/g		9.26	9.4	9.44	8.7	8.68	8.83	9.13			9.47	9.37	9.27		8.4	8.4		
D5185	Al	ppm	8	2	3	3	6	7	7	13	6	8	2	3	5		13	23		
	Cu	ppm	240	35	45	63	92	107	121	163	67	182	30	40	76		121	148		
	Fe	ppm	12	3	3	3	6	8	6	10	6	13	3	4	8		13	17		
	Pb	ppm	11	1	3	4	6	7	7	11	5	10	2	3	6		10	12		
	Si	ppm	20	7	8	8	9	9	10	12	6	58	14	19	22		25	29		
	Cd	ppm	16	2	3	5	8	11	14	22	11	11	2	3	6		16	23		
D664 Acid	TAN Buffer	mg KOH/g	1.71	1.87	1.96	1.94	1.57	1.83	1.77	1.45		1.68	1.95	1.8	1.8		1.89	1.73		

Note: Bold vertical lines in between data columns indicate an oil change

HMMWV (engine)

- LW024 (TEST) received an unnecessary oil change between 7th & 8th QTR. The oil change was not skipped during annual service by maintenance personnel as instructed.
- LW026 (TEST) received an unnecessary oil change between 4th & 6th QTR. The oil change was not skipped during annual service by maintenance personnel as instructed.
- LW027 (TEST) received new engine shortly before the start of the field demonstration. As a result critical wear metals measured in that engine were higher than other units throughout all testing as a result of engine break in. Silicon levels were also increased, and in this case is likely attributed to leaching of silicon containing sealant compounds common in a new engines.
- LW028 (TEST) showed slightly increase iron and silicon content at EOT. Increasing silicon levels suggest some amount of dirt ingestion as a result of improper or poor filtration, resulting in increased abrasive wear and iron accumulation.
- Apart from LW027 & LW028 (TEST), iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 9), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- All used oil analysis results from LW027 and LW028 (TEST), which did NOT receive oil changes for the full two year duration, suggest that the SCPL is capable of extended drain intervals. EOT TBN numbers for both remained higher than TBN values for the CONTROL HMMWV's prior to their normally scheduled oil changes.

Table 8. Ft. Benning UOA, HMMWV Engine, TEST

TEST Engine

HMMWV - LW024

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	8073	8407.4	8843	9081.3	9691.4	10587	-	12128
			Accum.	-	334.4	770	1008.3	1618.4	2514.3	-	4054.7
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				80.2%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	14.58	9.68	9.8	9.94	9.95	10.1	10	Sample Not Available	9.05
D445 40c	Viscosity	cSt		55.6					60.07		
D2270	Viscosity Index			160					153		
D4739	TBN Buffer	mg KOH/g		9.06	8.82	8.27	6.83	6.83	6.48		
D5185	Al	ppm	2	1	2	3	3	4	3		2
	Cu	ppm	2	<1	1	2	3	3	4		2
	Fe	ppm	17	6	19	44	48	51	55		20
	Pb	ppm	4	<1	4	7	7	8	9		4
	Si	ppm	11	7	13	20	22	24	30		12
D664 Acid	TAN Buffer	mg KOH/g		1.91	1.83	1.91	1.89	2.08	2.49		

HMMWV - LW026

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	7482	8015.4	8669.4	8874	8888.2	9956.7	10536	10625
			Accum.	-	533.4	1187.4	1392	1406.2	2474.7	3053.5	3143
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				77.1%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	14.63	9.88	9.84	10.02	10.18	10.27	8.68	9.23	9.04
D445 40c	Viscosity	cSt		57.32				60.82	49.25		50.29
D2270	Viscosity Index			159				IC	156		162
D4739	TBN Buffer	mg KOH/g		8.77	8.32	7.63	6.05	6.5	8.12	8.31	7.82
D5185	Al	ppm	4	2	3	3	3	3	1	2	2
	Cu	ppm	3	<1	2	3	4	4	1	3	2
	Fe	ppm	72	22	33	42	56	50	22	39	34
	Pb	ppm	6	2	4	5	7	6	2	4	4
	Si	ppm	22	10	19	30	37	31	14	25	19
D664 Acid	TAN Buffer	mg KOH/g		2.08	2.33	2.27	2.14	2.4	2.15	1.87	2.3

TEST Engine

HMMWV - LW027

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	7480	7541.1	7782	8306.8	8797.8	9876.6	10481	11620
			Accum.	-	61.1	302	826.8	1317.8	2396.6	3000.5	4140
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				91.1%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	14.56	9.01	9.57	9.61	9.72	9.71	9.88	9.93	10.31
D445 40c	Viscosity	cSt		49.62							59.16
D2270	Viscosity Index			164							164
D4739	TBN Buffer	mg KOH/g		9.73	9.45	8.65	7.4	7.35	6.4	6.97	6.54
D5185	Al	ppm	2	1	2	3	3	3	4	4	5
	Cu	ppm	14	2	7	12	14	14	15	17	15
	Fe	ppm	26	4	42	79	82	84	110	125	124
	Pb	ppm	32	4	18	37	42	53	49	53	46
	Si	ppm	58	11	54	106	123	119	121	139	117
D664 Acid	TAN Buffer	mg KOH/g		2.02	1.95	1.76	1.62	2.03	2.27	2.07	2.82

HMMWV - LW028

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	49298	49476	50007	50442	51164	51935	52434	53287
			Accum.	-	177.8	709	1144.1	1865.5	2636.8	3136.3	3988.8
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
				84.4%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	14.57	9.42	9.72	9.88	10.02	10.39	10.32	10.05	10.8
D445 40c	Viscosity	cSt		52.9							64.32
D2270	Viscosity Index			163							159
D4739	TBN Buffer	mg KOH/g		9.23	8.98	8.3	7.87	6.44	6.05	6.58	6.14
D5185	Al	ppm	2	1	2	3	3	4	4	4	6
	Cu	ppm	2	<1	<1	4	6	6	6	7	8
	Fe	ppm	36	8	23	36	43	55	67	90	144
	Pb	ppm	3	<1	3	10	12	12	13	14	17
	Si	ppm	11	6	14	29	32	34	37	39	45
D664 Acid	TAN Buffer	mg KOH/g		2.03	2.01	1.88	1.71	2.33	2.63	2.19	3.35

Table 9. Ft. Benning UOA, HMMWV Engine, CONTROL

CONTROL Engine

HMMWV - LW394

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	29038	29566	30681	31454	32079	32895	33195	33573
			Accum.	-	528.4	1643	2416.3	3041.1	3856.9	4157	4535
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
D445 100c	Viscosity	cSt		14.62	14.52	14.43	14.72				14.44
D445 40c	Viscosity	cSt		109.57			110.62				
D2270	Viscosity Index			137			137				
D4739	TBN Buffer	mg KOH/g		6.29	6.68	4.79	5.4				
D5185	Al	ppm		2	2	3	3	1	3	4	2
	Cu	ppm		4	4	5	6	2	4	4	1
	Fe	ppm		27	33	42	47	18	37	67	19
	Pb	ppm		14	15	17	18	6	7	9	3
	Si	ppm		12	13	16	18	8	14	16	7
D664 Acid	TAN Buffer	mg KOH/g		2.11	2.28	2.29	2.43				

HMMWV - LW395

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	5339	5477.4	5606	5982.8	6505.9	7295.2	7753.3	8089.2
			Accum.	-	138.4	267	643.8	1166.9	1956.2	2414.3	2750.2
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
D445 100c	Viscosity	cSt		14.85	14.35	14.37	14.26	14.56	14.37	14.42	14.34
D445 40c	Viscosity	cSt						109.64			108.21
D2270	Viscosity Index							IC			135
D4739	TBN Buffer	mg KOH/g			8.15	7.44	7.31	7.44	5.96	5.6	5.23
D5185	Al	ppm		1	3	2	3	1	3	4	4
	Cu	ppm		2	2	3	4	2	4	4	5
	Fe	ppm		24	47	44	48	21	51	58	62
	Pb	ppm		3	5	5	6	2	4	6	6
	Si	ppm		9	10	11	14	7	12	25	24
D664 Acid	TAN Buffer	mg KOH/g			2.19	1.94	1.86	2.09	2.3	2.4	2.45

Note: Bold vertical lines in between data columns indicate an oil change

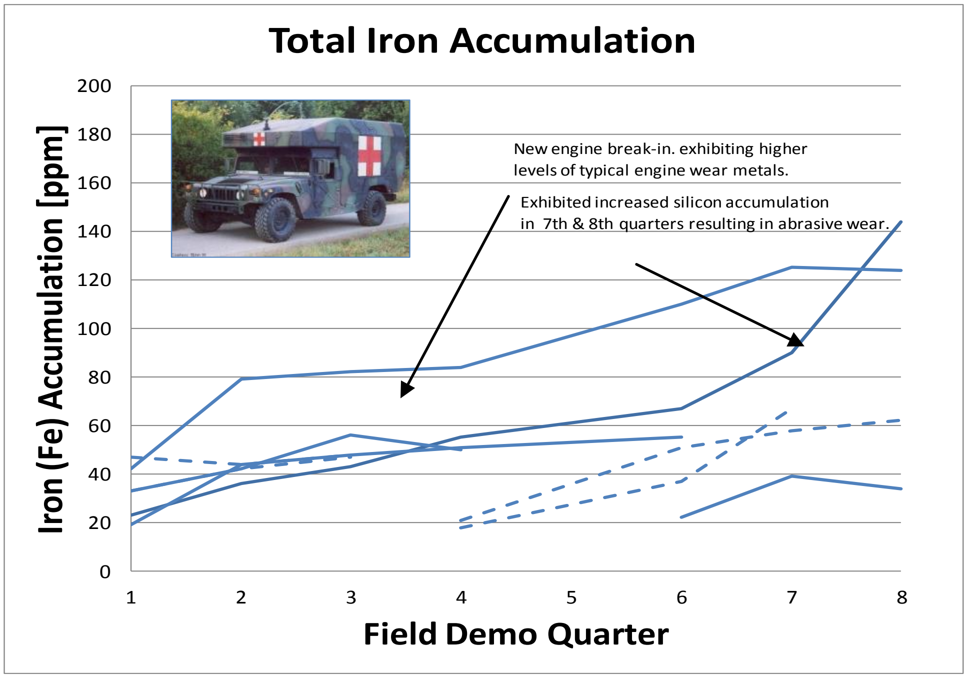

Figure 9. Ft. Benning UOA, HMMWV Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

HEMTT (engine)

- HW334 (TEST) was inadvertently changed back to MIL-PRF-2104 products by maintenance personnel after the 4th QTR by maintenance personnel. Unit remained off test for the rest of the duration.
- HW338 (TEST) received an unnecessary oil change between 7th & 8th QTR. The oil change was not skipped during annual service by maintenance personnel as instructed.
- HW338 (TEST) and HW361 (CONTROL) exhibited elevated copper (Cu) levels at varying levels. Copper accumulation has been learned to be typical in new engines of this engine family, and is attributed to leaching from copper containing brazing materials present on internal oil cooler components. Copper leaching occurs until the surfaces become passive, which occurs as the component ages.
- Fe accumulation rates between TEST and CONTROL were found to be similar (see Figure 10), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.

- No other significant source of wear metals were identified in the HEMTT vehicles that would suggest an incompatibility with the SCPL.
- All used oil analysis results from HW336 and HW337 (TEST), which did NOT receive oil changes for the full two year duration, suggest that the SCPL is capable of extended drain intervals.

Table 10. Ft. Benning UOA, HEMTT Engine, TEST

TEST Engine — HEMTT - HW334

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	1752	1826.6	1834.3	1910.1	2433.3	2877.9	2960.3	2976.3	
		Accum.	-	74.6	82.3	158.1	681.3	1125.9	1208.3	1224.3	
		Hours	172	217.3	219.45	272.05	276.05	319.2	333.25	337.9	
		Accum.	-	45.3	47.45	100.05	104.05	147.2	161.25	165.9	
				77.2%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	11.41	9.14	9.14	8.63	8.67	9.05	No Longer On Test, Oil Changed to MIL-PRF-2104		
D445 40c	Viscosity	cSt		52.4				50.45			
D2270	Viscosity Index			157				IC			
D4739	TBN Buffer	mg KOH/g		8.7	8.5	8.42	7.29	7.18			
D5185	Al	ppm	3	2	2	2	2	2			
	Cu	ppm	106	32	38	38	41	59			
	Fe	ppm	27	9	17	17	19	27			
	Pb	ppm	7	2	3	3	3	3			
	Si	ppm	85	29	34	34	35	39			
D664 Acid	TAN Buffer	mg KOH/g		2	2.01	1.93	1.55	2.11			

TEST Engine — HEMTT - HW336

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	794	1042	1174.1	1174.3	1333.4	1523.1	1624.8	1750.8	
		Accum.	-	248	380.1	380.3	539.4	729.1	830.8	956.8	
		Hours	100	133.2	149.6	151.65	169.25	209.6	221.85	240.3	
		Accum.	-	33.2	49.6	51.65	69.25	109.6	121.85	140.3	
				76.6%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	10.48	8.94	8.9	8.83	8.65	8.88	8.67	8.49	8.8
D445 40c	Viscosity	cSt		50.02							48.53
D2270	Viscosity Index			160							162
D4739	TBN Buffer	mg KOH/g		8.79	8.44	8.18	6.93	7.38	6.7	7.4	6.64
D5185	Al	ppm	2	1	2	2	2	2	2	2	2
	Cu	ppm	59	16	27	30	31	36	42	42	44
	Fe	ppm	20	6	16	22	21	28	37	43	55
	Pb	ppm	6	2	3	3	3	3	3	3	3
	Si	ppm	83	26	35	37	38	41	45	42	43
D664 Acid	TAN Buffer	mg KOH/g		1.93	1.8	1.77	1.68	1.9	1.91	1.66	2.29

TEST Engine — HEMTT - HW337

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	246	459.1	544.9	1075.6	1980.9	3154.1	3485.3	4795.1	
		Accum.	-	213.1	298.9	829.6	1734.9	2908.1	3239.3	4549.1	
		Hours	33	58.1	72.7		184.5	277.4	301.4	400.05	
		Accum.	-	25.1	39.7		151.5	244.4	268.4	367.05	
				71.6%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	10.48	9.04	8.88	8.64	8.9	9.04	8.85	9.02	9.05
D445 40c	Viscosity	cSt		50.04							50.19
D2270	Viscosity Index			163							163
D4739	TBN Buffer	mg KOH/g		9.09	8.93	8.68	7.98	6.73	5.5	5.66	4.74
D5185	Al	ppm	1	1	2	2	2	2	3	3	3
	Cu	ppm	23	6	14	17	24	32	41	46	61
	Fe	ppm	10	4	14	22	26	31	40	59	66
	Pb	ppm	3	<1	2	2	2	2	3	2	3
	Si	ppm	75	25	36	40	48	53	62	64	65
D664 Acid	TAN Buffer	mg KOH/g		1.95	1.92	1.65	1.63	1.88	2.46	1.91	2.63

TEST Engine — HEMTT - HW338

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	4086	4952.6	5361.1	6111.8	6759.5	7795.2	8325.8	9613.8	
		Accum.	-	866.6	1275.1	2025.8	2673.5	3709.2	4239.8	5527.8	
		Hours	297	361.4	390.7	448.8	493.65	586.55	632.05	721.15	
		Accum.	-	64.4	93.7	151.8	196.65	289.55	335.05	424.15	
				77.5%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	10.69	8.97	8.9	8.72	9.01	8.42	8.23	8.83	8.96
D445 40c	Viscosity	cSt		50.23						48.95	
D2270	Viscosity Index			160						162	
D4739	TBN Buffer	mg KOH/g		8.22	7.15	6.86	4.8	5.36	5.04	5.42	
D5185	Al	ppm	3	2	2	3	3	3	4	3	3
	Cu	ppm	192	54	81	87	109	123	382	741	61
	Fe	ppm	36	11	24	31	36	43	51	58	66
	Pb	ppm	7	2	3	3	3	3	3	3	3
	Si	ppm	83	27	33	35	40	38	41	40	65
D664 Acid	TAN Buffer	mg KOH/g		2.07	1.98	2.1	2.13	2.34	2.46	2.27	

Note: Bold vertical lines in between data columns indicate an oil change

Table 11. Ft. Benning UOA, HEMTT Engine, CONTROL

CONTROL Engine			HEMTT - HW360								
			Miles	207	332.3	782.6	782.9	816	820	1207.9	1293.1
			Accum.	-	125.3	575.6	575.9	609	613	1000.9	1086.1
			Hours	25	60.95	107.25	110.1	121.05	134.45	177.45	197.8
			Accum.	-	35.95	82.25	85.1	96.05	109.45	152.45	172.8
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
Method	**Property**	**Units**									
D445 100c	Viscosity	cSt		11.52	11.43	11.66	11.33	11.48	11.11	11.03	10.95
D445 40c	Viscosity	cSt		79.41							73.05
D2270	Viscosity Index			137							139
D4739	TBN Buffer	mg KOH/g		8.02	8.22	6.9	7.54	6.97	6.62	6.26	6.03
D5185	Al	ppm		2	2	2	2	2	4	4	4
	Cu	ppm		36	42	61	62	67	74	86	94
	Fe	ppm		11	14	19	19	24	40	55	62
	Pb	ppm		4	6	6	6	6	6	7	6
	Si	ppm		78	80	86	84	87	91	86	89
D664 Acid	TAN Buffer	mg KOH/g		1.88	1.9	2.02	1.72	2.02	1.88	2.25	2.29

CONTROL Engine			HEMTT - HW361								
			Miles	1607	1931.2	2018.9	2153.5	2439.5	3257.2	3607.1	4795.7
			Accum.	-	324.2	411.9	546.5	832.5	1650.2	2000.1	3188.7
			Hours	159	188.7	119.9	208.95	234.2	315.85	342.35	440.7
			Accum.	-	29.7	-	49.95	75.2	156.85	183.35	281.7
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
Method	**Property**	**Units**									
D445 100c	Viscosity	cSt		11.48	11.79	11.39	11.35	11.51			12.5
D445 40c	Viscosity	cSt		79.38				79.56			
D2270	Viscosity Index			136				IC			
D4739	TBN Buffer	mg KOH/g		6.58	7.06	5.99	6.31	5.58			
D5185	Al	ppm		2	3	3	3	3	2	2	3
	Cu	ppm		97	113	118	124	144	62	69	88
	Fe	ppm		25	38	39	43	49	35	56	65
	Pb	ppm		5	6	6	6	6	2	2	3
	Si	ppm		84	88	89	88	91	35	36	40
D664 Acid	TAN Buffer	mg KOH/g		2.28	2.2	2.08	2.29	2.38			

Note: Bold vertical lines in between data columns indicate an oil change

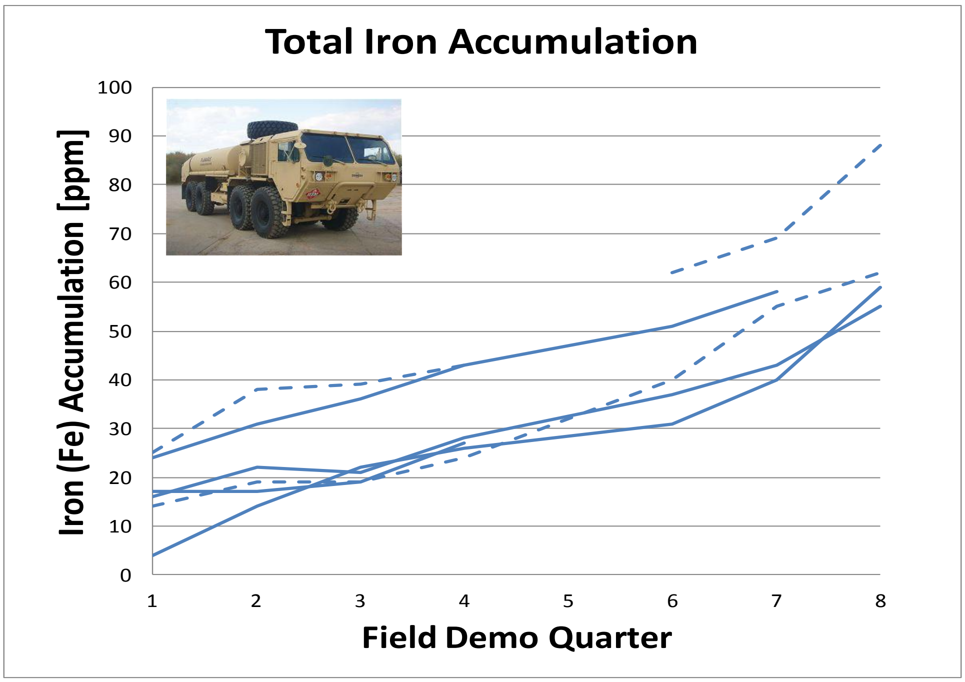

Figure 10. Ft. Benning UOA, HEMTT Engine, Iron Accumulation

Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

HEMTT (transmission)

- Similar to that completed for the Bradley vehicle, no CONTROL transmission samples were acquired for the HEMTT for comparison.
- Wear metal analysis does not show any significant accumulation of typical wear metals (aluminum, iron, lead, etc).
- No operational issues were noted regarding transmission function with units utilizing the SCPL.

Table 12. Ft. Benning UOA, HEMTT Transmission, TEST

TEST Trans.			HEMTT - HW337								
			Miles	246	459.1	544.9	1075.6	1980.9	3154.1	3485.3	4795.1
			Accum.	-	213.1	298.9	829.6	1734.9	2908.1	3239.3	4549.1
			Hours	33	58.1	72.7	434.2	184.5	277.4	301.4	400.05
			Accum.	-	25.1	39.7	401.2	151.5	244.4	268.4	367.05
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
Method	**Property**	**Units**		75.4%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	11.8	9.29	9.17	9.12	8.84	8.69	8.51	8.34	8.43
D445 40c	Viscosity	cSt		52.5							46.96
D2270	Viscosity Index			161							157
D4739	TBN Buffer	mg KOH/g		8.64	8.79	8.94	8.42	8.28	8.37	8.93	8.24
D5185	Al	ppm	1	1	2	2	2	2	3	3	3
	Cu	ppm	7	2	3	4	4	5	7	7	8
	Fe	ppm	8	3	5	5	6	7	9	9	10
	Pb	ppm	2	<1	1	1	1	1	<1	2	2
	Si	ppm	5	5	5	5	4	3	4	4	4
D664 Acid	TAN Buffer	mg KOH/g	1.37	1.93	2.08	1.73	1.5	1.86	1.6	1.47	1.67

TEST Trans.			HEMTT - HW338								
			Miles	4086	4952.6	5361.1	6111.8	6759.5	7795.2	8325.8	9613.8
			Accum.	-	866.6	1275.1	2025.8	2673.5	3709.2	4239.8	5527.8
			Hours	297	361.4	390.7	448.8	493.65	586.55	632.05	721.15
			Accum.	-	64.4	93.7	151.8	196.65	289.55	335.05	424.15
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
Method	**Property**	**Units**		72.1%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	cSt	10.26	8.97	8.75	8.65	8.45	8.42	8.29	8.1	8.32
D445 40c	Viscosity	cSt		50.59							46.43
D2270	Viscosity Index			159							156
D4739	TBN Buffer	mg KOH/g		8.52	8.69	8.82	8.34	8.05	8.08	8.69	8.06
D5185	Al	ppm	4	2	3	3	3	4	4	4	5
	Cu	ppm	36	11	13	12	13	14	15	14	16
	Fe	ppm	15	6	9	8	9	10	10	11	12
	Pb	ppm	4	<1	2	1	1	2	1	2	2
	Si	ppm	5	5	4	4	4	4	4	4	4
D664 Acid	TAN Buffer	mg KOH/g	1.19	1.7	1.63	1.76	1.43	1.75	1.7	1.37	1.6

HET (engine + transmission)

- Only one HET was available at the start of testing, so results are only reported for the TEST vehicle, as no CONTROL vehicle was available.
- Limited maintenance history of HW127 was available prior to the changeover to SCPL, but inclusion of equipment using a 2-cycle diesel engine was highly desired, so the vehicle was included without any known background.
- Immediately after the start of testing HW127 (TEST) experienced a head gasket failure which required a full replacement of the engine. The engine failure was not attributed to the use of SCPL, and the newly replaced engine was filled with the SCPL at the completion of maintenance.
- As a result of the new engine break-in, typical wear metals (Fe, Cu, Pb) remained higher than normal through the remainder of the test. In addition, Si levels were also high, again attributed to silicon containing sealants typically used in new engines. Despite these

elevated levels, trends did not show exponential accumulation that is typically associated with increased wear and scuffing in 2-cycle engines [2,3].

- As there were no CONTROL HET's included in the test, no CONTROL transmission samples were acquired.
- Wear metal analysis of the HW127 (TEST) transmission samples does not show significant accumulation of typical wear metals (aluminum, iron, lead, etc).
- No operational issues were noted regarding the HET transmission function using the SCPL.

Table 13. Ft. Benning UOA, HET Engine, TEST

TEST Engine			HET - HW127								
			Miles	17810	-	592.6	692.7	790.8	911.5	921.8	922.3
			Accum.	-	-	-					
			Hours	-	-	80.9	101.2	110.3	127	129.4	131.2
			Accum.	-	-	-					
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units	11.42	9.05	Out of service, Engine head gasket failure	9.05	9.11	8.95	8.8	8.75	8.84
D445 100c	Viscosity	cSt				50.59					48.37
D445 40c	Viscosity	cSt				161					164
D4739	TBN Buffer	mg KOH/g		9.05		8.65	8.35	7.63	7.23	7.95	7.55
D5185	Al	ppm	1	1		3	2	3	2	2	2
	Cu	ppm	7	1		29	30	33	36	32	33
	Fe	ppm	137	26		60	69	81	95	85	87
	Pb	ppm	3	<1		15	14	15	16	14	13
	Si	ppm	41	13		121	132	141	159	135	134
D664 Acid	TAN Buffer	mg KOH/g		2.06		2.08	1.88	2.1	1.91	1.68	2.14

Note: Bold vertical lines in between data columns indicate an oil change

Table 14. Ft. Benning UOA, HET Transmission, TEST

TEST Trans.			HET - HW127								
			Miles	17810	-	592.6	692.7	790.8	911.5	921.8	922.3
			Accum.	-	-	-					
			Hours	-	-	80.9	101.2	110.3	127	129.4	131.2
			Accum.	-	-	-					
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units			Out of service, Engine head gasket failure						
D445 100c	Viscosity	cSt	6.86	8.21		8.13	8.28	8.18	7.9	8.05	8.13
D445 40c	Viscosity	cSt		44.64							44.14
D2270	Viscosity Index			161							160
D4739	TBN Buffer	mg KOH/g		8.61		8.98	8.81	8.09		8.86	8.28
D5185	Al	ppm	18	4		4	3	3	4	3	4
	Cu	ppm	217	33		33	36	38	40	42	41
	Fe	ppm	53	9		8	8	8	10	9	9
	Pb	ppm	15	2		3	3	4	4	4	4
	Si	ppm	6	5		6	7	6	7	8	7
D664 Acid	TAN Buffer	mg KOH/g	1.48	1.85		1.72	1.53	1.79	1.97	1.52	1.9

MTV (engine)

- All TEST MTVs operated the full 2-year duration without any unnecessary oil changes.
- No issues were identified in critical wear metals for the TEST or CONTROL MTVs.
- Fe accumulation rates between TEST and CONTROL were found to be similar (see Figure 11), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- Used oil analysis results from all TEST vehicles (which did NOT receive oil changes for the full two year duration), suggest that the SCPL is capable of extended drain intervals.

Table 15. Ft. Benning UOA, MTV Engine, TEST

TEST Engine			MTV - HW289								
			Miles	12789	13787	13787	13930	14086	14185	14188	14555
			Accum.	-	998	998	1141	1297	1396	1399	1766
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		93.5%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.64	8.74	8.88	8.93	8.95	9.33	9.16	9.14	9.21
D445 40c	Viscosity	cSt		47.42							52.68
D2270	Viscosity Index			166							158
D4739	TBN Buffer	mg KOH/g		9.62	9.01	8.93	7.58	7.8	7.86	8.19	7.07
D5185	Al	ppm	<1	1	2	2	<1	1	<1	1	2
	Cu	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Fe	ppm	7	2	3	3	4	4	5	6	9
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	1	<1
	Si	ppm	3	5	4	4	4	4	4	5	5
D664 Acid	TAN Buffer	mg KOH/g		1.97	1.92	1.9	1.66	1.98	1.99	1.63	2.25

TEST Engine			MTV - HW290								
			Miles	10887	11310	11593	11851	12439	12895	12915	13505
			Accum.	-	423	706	964	1552	2008	2028	2618
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		92.9%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.99	8.79	8.98	8.92	9.01	8.45	8.38	8.35	8.45
D445 40c	Viscosity	cSt		48.26							45.64
D2270	Viscosity Index			163							164
D4739	TBN Buffer	mg KOH/g		9.42	8.82	8.47	6.43	8.24	7.89	8.87	7.51
D5185	Al	ppm	<1	1	2	2	1	2	1	1	2
	Cu	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Fe	ppm	3	1	4	6	6	4	7	8	10
	Pb	ppm	<1	<1	<1	<1	1	<1	<1	<1	<1
	Si	ppm	3	5	4	4	4	4	5	5	4
D664 Acid	TAN Buffer	mg KOH/g		2.1	2.08	2.09	1.94	2.04	2.18	1.83	2.56

TEST Engine			MTV - HW291								
			Miles	12785	12855	13092	13131	13187	13683	13738	14179
			Accum.	-	70	307	346	402	898	953	1394
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		86.0%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.54	9.04	8.98	8.87	9.04	8.88	8.6	8.6	8.79
D445 40c	Viscosity	cSt		50.41							48.77
D2270	Viscosity Index			162							161
D4739	TBN Buffer	mg KOH/g		9.01	9.15	8.75	8.61	8.02	7.49	7.73	7.04
D5185	Al	ppm	<1	1	2	2	<1	1	<1	<1	2
	Cu	ppm	3	<1	<1	<1	1	1	1	2	2
	Fe	ppm	7	2	4	4	4	5	6	8	10
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	1
	Si	ppm	3	5	4	4	4	4	5	5	5
D664 Acid	TAN Buffer	mg KOH/g		1.93	1.89	1.86	1.7	1.9	2.17	1.84	2.4

TEST Engine			MTV - HW301								
			Miles	12159	-	12253	12296	12455	12492	12637	12819
			Accum.	-	-	94	137	296	333	478	660
			-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		90.1%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	13.32	8.95	8.89	8.81	8.92	8.74	8.46	8.38	8.65
D445 40c	Viscosity	cSt		49.57							47.36
D2270	Viscosity Index			163							163
D4739	TBN Buffer	mg KOH/g		9.37	9.53	9.62	9.36	8.53	8.7	8.75	8.04
D5185	Al	ppm	<1	1	2	2	<1	1	<1	<1	2
	Cu	ppm	2	<1	<1	2	<1	<1	<1	2	1
	Fe	ppm	5	2	2	3	3	4	4	6	8
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Si	ppm	2	5	4	4	4	4	5	5	5
D664 Acid	TAN Buffer	mg KOH/g		2.05	1.86	1.95	1.56	1.84	1.79	1.48	2.12

Table 16. Ft. Benning UOA, MTV Engine, CONTROL

CONTROL Engine			MTV - HW302									MTV - HW303								
			Miles	12725	13487	13578	13578	13579	13626	13645	13646	Miles	5421	5545	5615	5615	5647	5806	5837	7448
			Accum.	-	762	853	853	854	901	920	921	Accum.	-	124	194	194	226	385	416	2027
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units																		
D445 100c	Viscosity	cSt		13.58	12.82	12.68	12.82	13.02	13.71	13.64	13.55		13.4	13.28	14.38	14.38	13.84	13.68	13.65	12.75
D445 40c	Viscosity	cSt		100.11							100.8		98.46							93.38
D2270	Viscosity Index			136							134		135							133
D4739	TBN Buffer	mg KOH/g		8.29	8.12	7.4	7.81	7.35	8.65	8.58	8.51		7.95	8.64	8.84	8.98	8.59	8.51	8.44	6.63
D5185	Al	ppm		<1	<1	<1	<1	<1	<1	<1	1		<1	<1	<1	<1	<1	<1	<1	1
	Cu	ppm		<1	<1	<1	<1	<1	<1	<1	<1		1	1	<1	<1	<1	<1	<1	1
	Fe	ppm		2	4	4	4	4	2	2	2		3	4	2	2	2	2	3	7
	Pb	ppm		<1	<1	1	<1	<1	<1	1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Si	ppm		3	3	3	3	3	5	4	4		3	3	5	5	3	4	4	3
D664 Acid	TAN Buffer	mg KOH/g		1.93	2.29	2.07	1.84	2.2	2.18	2.17	2.21		1.98	1.86	2.12	1.74	2.06	2.14	2.28	2.51

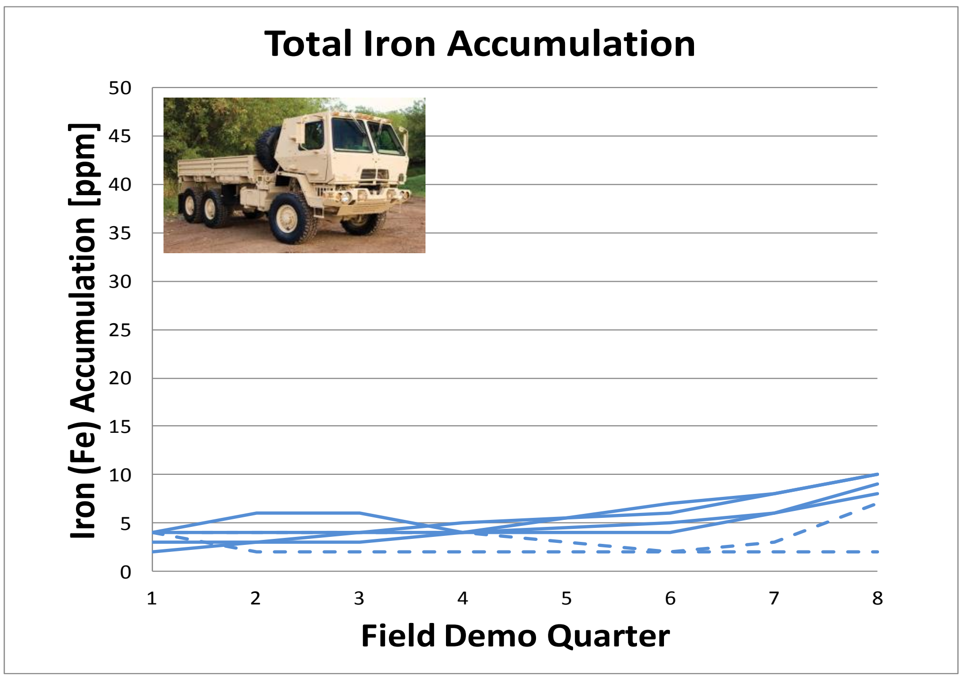

Figure 11. Ft. Benning UOA, MTV Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

MTV (transmission)

- Similar to that completed for the previous vehicles, no CONTROL transmission samples were acquired for the MTV for comparison.
- High levels of copper (Cu) accumulation were observed in both of the TEST MTV transmissions. The source of this copper is unknown, but as found samples removed from

the vehicles at the start of testing also showed high copper levels. This, combined with data presented in the Ft. Wainwright results suggests that copper accumulation could be normal for this type transmission.

- No other significant wear metal accumulations were identified (aluminum, iron, lead, etc).
- No operational issues were noted regarding transmission function with units utilizing the SCPL.

Table 17. Ft. Benning UOA, MTV Transmission, TEST

TEST Trans.			MTV - HW291									MTV - HW301								
			Miles	12785	12855	13092	13131	13187	13683	13738	14179	Miles	12159	12296	12296	N/A	12455	12492	12637	12819
			Accum.	-	70	307	346	402	898	953	1394	Accum.	-	137	137	N/A	296	333	478	660
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
Method	Property	Units		54.9%	% initial changeover (calculated from vis)								56.4%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	10.09	9.2	8.98	8.89	8.86	8.94	8.78	8.73	8.78	10.58	9.39	9.07	8.99	9.07	9.01	8.85	8.84	8.94
D445 40c	Viscosity	cSt		54.88							51.67		57.84							53.03
D2270	Viscosity Index			149							149		144							149
D4739	TBN Buffer	mg KOH/g		8.52	8.72	8.48	7.87	7.51	7.81	8.19	7.69		8.24	8.78	8.95	8.22	7.98	8.26	8.6	8.1
D5185	Al	ppm	9	5	5	5	4	5	4	4	5	9	5	5	5	4	4	3	4	5
	Cu	ppm	414	194	170	174	184	200	205	223	252	348	181	138	146	157	182	201	237	294
	Fe	ppm	57	29	25	24	24	25	24	25	28	64	34	25	26	25	25	24	27	31
	Pb	ppm	12	6	6	5	5	5	5	6	5	7	3	4	3	3	3	3	4	3
	Si	ppm	10	7	7	6	6	6	6	6	6	8	6	6	6	6	5	6	6	6
D664 Acid	TAN Buffer	mg KOH/g	1.1	1.58	1.47	1.44	1.25	1.63	1.51	1.25	1.64	1.57	1.87	1.77	1.58	1.47	1.76	1.73	1.48	1.59

STRYKER (engine)

- All TEST STRYKERS operated the full 2-year duration without any unnecessary oil changes.
- The STRYKER utilizes an on-board oil addition system to maintain engine oil levels over long durations. This was drained and filled with SCPL prior to testing to ensure oil added was only the SCPL.
- No issues were identified in critical wear metals for the TEST or CONTROL MTVs.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 12), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- All STRYKER used oil analysis results suggest that the SCPL is capable of extended drain intervals.

Table 18. Ft. Benning UOA, STRYKER Engine, TEST

TEST Engine — STRYKER - B52

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			11674	11782	11795	11810	12001	12248	12521	12537
	Accum.			-	107.8	120.6	135.7	326.6	574.2	846.8	862.9
	Hours			1462	1486.9	1493.7	1499.1	1520.4	1555.2	1579.8	1583.1
	Accum.			-	24.9	31.7	37.1	58.4	93.2	117.8	121.1
				89.6%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.5	8.89	8.89	8.88	8.76	9.05	9.45	9.53	9.59
D445 40c	Viscosity	cSt			49.67						56.08
D2270	Viscosity Index				160						156
D4739	TBN Buffer	mg KOH/g		9.32	9.2	9.08	8.07	7.64	7.72	7.6	7.11
D5185	Al	ppm	1	1	2	2	1	2	1	2	2
	Cu	ppm	3	<1	1	2	2	2	2	3	3
	Fe	ppm	10	2	9	10	10	15	12	17	22
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	2	1
	Si	ppm	3	4	4	4	3	4	4	4	4
D664 Acid	TAN Buffer	mg KOH/g		1.93	1.78	1.72	1.5	1.96	1.9	1.83	2.22

TEST Engine — STRYKER - B53

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			5955	6086.1	6134.8	6164.4	6288.1	6623.9	6716.8	6815.8
	Accum.			-	131.1	179.8	209.4	333.1	668.9	761.8	860.8
	Hours			1431	1469.7	1477.9	1491.2	1524.3	1579.1	1592.6	1614.4
	Accum.			-	38.7	46.9	60.2	93.3	148.1	161.6	183.4
				87.5%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	12.3	8.95	8.88	8.92	8.95	8.88	8.83	8.92	9.36
D445 40c	Viscosity	cSt		50.25							52.86
D2270	Viscosity Index			160							161
D4739	TBN Buffer	mg KOH/g		9.24	9.08	8.7	7.39	7.28	7.22	7.43	7
D5185	Al	ppm	2	1	2	2	2	2	2	2	3
	Cu	ppm	6	<1	2	2	3	3	3	4	4
	Fe	ppm	18	4	10	10	10	12	15	19	20
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Si	ppm	5	5	4	4	4	4	4	5	4
D664 Acid	TAN Buffer	mg KOH/g		1.96	1.78	1.69	1.59	1.89	2.19	1.94	2.23

TEST Engine — STRYKER - B54

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			3013	3085.9	3237.2	3356.1	3478.1	3623.5	3701	3701.1
	Accum.			-	72.9	224.2	343.1	465.1	610.5	688	688.1
	Hours			584	628.9	654.9	689.8	724.5	775.5	788.6	792.5
	Accum.			-	44.9	70.9	105.8	140.5	191.5	204.6	208.5
				87.8%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	14.28	9.18	9.13	9.22	9.45	9.49	9.17	9.05	10
D445 40c	Viscosity	cSt		51.29							59.35
D2270	Viscosity Index			162							155
D4739	TBN Buffer	mg KOH/g		9.62	9.24	8.72	8.1	6.85	7.19	6.26	6.23
D5185	Al	ppm	<1	1	2	2	2	2	2	6	5
	Cu	ppm	2	<1	1	2	2	3	3	7	5
	Fe	ppm	4	2	4	6	8	9	14	24	22
	Pb	ppm	1	<1	1	1	2	2	1	3	2
	Si	ppm	4	5	4	3	3	3	4	5	4
D664 Acid	TAN Buffer	mg KOH/g		1.89	1.89	1.77	1.78	2.02	2.08	2.17	2.47

TEST Engine — STRYKER - B55

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			27731	27732	27777	27781	27788	28013	28039	28072
	Accum.			-	0.9	46	49.5	57.4	282.1	308	341.1
	Hours			2571	2572.4	2581.5	2583	2584.5	2650	2653.5	2673.7
	Accum.			-	1.4	10.5	12	13.5	79	82.5	102.7
				88.2%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	cSt	13.56	9.07	9.07	8.78	8.88	8.85	8.92	9.15	9.34
D445 40c	Viscosity	cSt		50.78							53.32
D2270	Viscosity Index			161							159
D4739	TBN Buffer	mg KOH/g		9.16	9.46	9.35	9.14	8.3	7.87	8.28	7.58
D5185	Al	ppm	1	1	2	2	1	2	1	2	2
	Cu	ppm	<1	<1	<1	<1	<1	1	2	2	2
	Fe	ppm	16	4	10	10	9	11	15	19	22
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Si	ppm	3	4	5	4	4	4	4	5	5
D664 Acid	TAN Buffer	mg KOH/g		1.98	1.74	1.66	1.52	1.62	1.83	1.48	1.97

Table 19. Ft. Benning UOA, STRYKER Engine, CONTROL

CONTROL Engine — STRYKER - B56

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			30172	30214	30847	31674	32171	32692	32693	32709
	Accum.			-	41.9	674.7	1501.8	1998.7	2519.7	2520.5	2537
	Hours			5702	5706.1	5782.6	5882.3	5943.9	6026.4	6029.9	6033.6
	Accum.			-	4.1	80.6	180.3	241.9	324.4	327.9	331.6
D445 100c	Viscosity	cSt		12.92	13.02	13.26	13.25	13.18	13.23	13.28	13.45
D445 40c	Viscosity	cSt		94.54							98.77
D2270	Viscosity Index			134							136
D4739	TBN Buffer	mg KOH/g		6.17	6.94	5.58	5.84	5.33	5.87	5.87	5.87
D5185	Al	ppm		4	4	2	3	3	2	2	2
	Cu	ppm		4	4	2	4	3	3	3	2
	Fe	ppm		8	9	9	15	15	14	16	14
	Pb	ppm		<1	1	<1	<1	<1	<1	<1	<1
	Si	ppm		4	4	3	4	4	4	4	3
D664 Acid	TAN Buffer	mg KOH/g		1.83	2	2.21	2.3	2.52	2.47	2.3	2.29

CONTROL Engine — STRYKER - B57

Method	Property	Units	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles			30027	30089	30274	30278	30424	30707	-	30810
	Accum.			-	62.4	247.2	250.6	396.7	680	-	783
	Hours			4770	4797.9	4818.2	4819.5	4838.6	4874.6	-	4883.7
	Accum.			-	27.9	48.2	49.5	68.6	104.6	-	113.7
D445 100c	Viscosity	cSt		12.85	12.8	14.25	14.1	13.43	13.06	Sample Not Available	13.67
D445 40c	Viscosity	cSt		93.73					96.15		
D2270	Viscosity Index			134					134		
D4739	TBN Buffer	mg KOH/g		7.23	8.2	8.64	8.87	7.89	7.09		
D5185	Al	ppm		1	2	<1	<1	1	1		<1
	Cu	ppm		1	1	<1	<1	<1	1		<1
	Fe	ppm		14	15	4	7	13	18		7
	Pb	ppm		<1	<1	<1	<1	<1	<1		<1
	Si	ppm		3	3	3	3	2	3		3
D664 Acid	TAN Buffer	mg KOH/g		1.89	1.89	2.17	1.83	1.87	1.96		

Note: Bold vertical lines in between data columns indicate an oil change

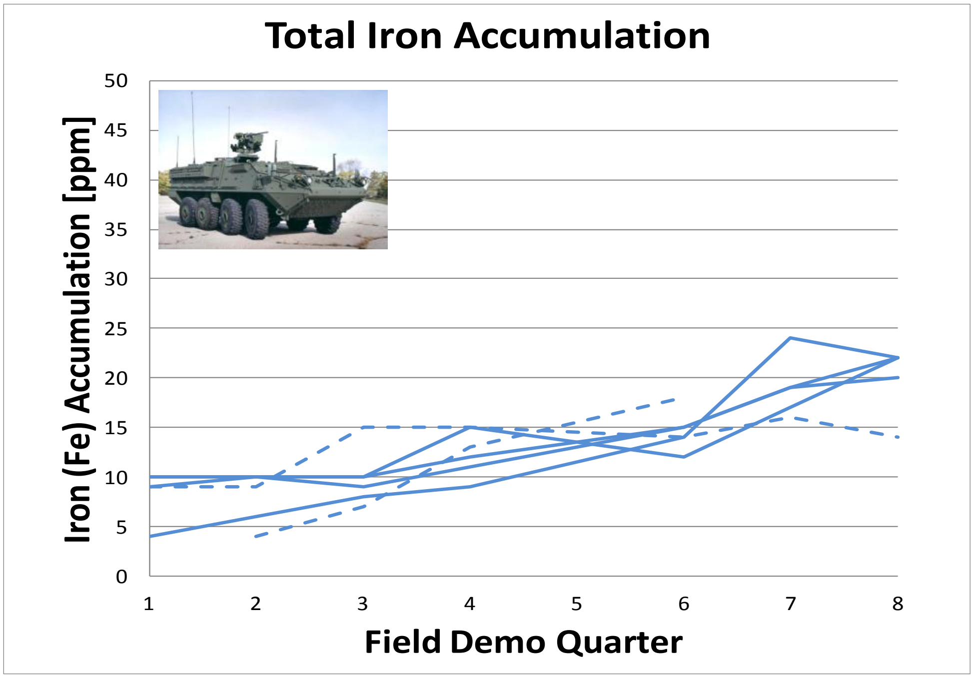

Figure 12. Ft. Benning UOA, STRYKER Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

4.2 Arctic Climate – Ft. Wainwright AK

For the arctic climate location, a total fleet of 16 vehicles were identified and included into the field demonstration. The total fleet size was constrained due to the high costs of conducting operations in Alaska, as well as for consideration of the more known performance of the SCPL in arctic environments (i.e., SCPL low viscosity formulation based on existing arctic oil technology). The 16 vehicle fleet consisted of 8 TEST vehicles and 8 CONTROL vehicles. Table 20 outlines the arctic climate vehicle fleet indicating vehicle type, description, model number, TEST/CONTROL designation, and its identification (bumper) number.

4.2.1 Problem Areas – Ft. Wainwright

Operation of the Ft. Wainwright field demonstration proved to be the easiest of all test locations, despite its geographical distance from the TFLRF facility, and no major problem areas were experienced during testing. This was attributed to the smaller overall vehicle fleet, and the excellent support provided by the Ft. Wainwright personnel. However, the same lack of fuel and oil consumption data existed at this location consistent with that seen at Ft. Benning. Ultimately as a result of the varying fuel sources used by the fleet vehicles, and the lack of any preexisting procedures in place to track oil usage apart from bulk POL consumption, specific oil and fuel

consumption data for the SCPL was not available, thus SCPL to OEA-30 comparison in this regard was not possible. Again this information is likely much better served by the laboratory testing conducted in the SCPL development phases of the program [1,2,3], where conditions were controlled tightly to determine actual changes.

Table 20. Ft. Wainwright Arctic Climate Vehicle Fleet

Vehicle Type	Description	Model	TEST/CONTROL	Bumper No.
HMMWV	Truck Ambulance	M997	TEST	BSMC-101*
			TEST	BSMC-104*
			CONTROL	BSMC-105
			CONTROL	BSMC-113
HEMMT	Fueler/Tanker	M1120A4	TEST	DC-111*
			TEST	DC-113*
			CONTROL	DC-112
			CONTROL	DC-114
MTV	Truck Cargo	M1083A1	TEST	HQ-31*
			TEST	HQ-32*
			CONTROL	HHC-153
			CONTROL	HHC-112
SUS-V	Cargo	M973A1	TEST	NWTC-2
			TEST	NWTC-3
			CONTROL	NWTC-4
			CONTROL	NWTC-34
* Denotes vehicles transmission included in SCPL evaluation				

4.2.2 Mileage Accumulation

Overall mileage accumulation by each vehicle type is shown graphically in the following plots. For all plots the solid blue lines represent the TEST vehicle mileage, the dashed blue lines represent the CONTROL vehicle mileage, and red dashed line represents the average mileage for the vehicle type as a whole. Full tabular mileage recordings for all vehicles are presented in the appendix, and includes quarterly mileage recordings, tabulated quarterly accumulation, and tabulated accumulation since start of test. In general, TEST versus CONTROL vehicle mileage for the arctic test location was comparable. Total overall utilization of the fleet was lower than other testing locations, and is primarily attributed to the severe weather conditions and more limited unit activity in the extreme weather during winter months. Although actual mileage accumulation was low, engine idle time remained high, as all vehicles were started weekly and allowed to operate until fully warm to ensure full time readiness of equipment.

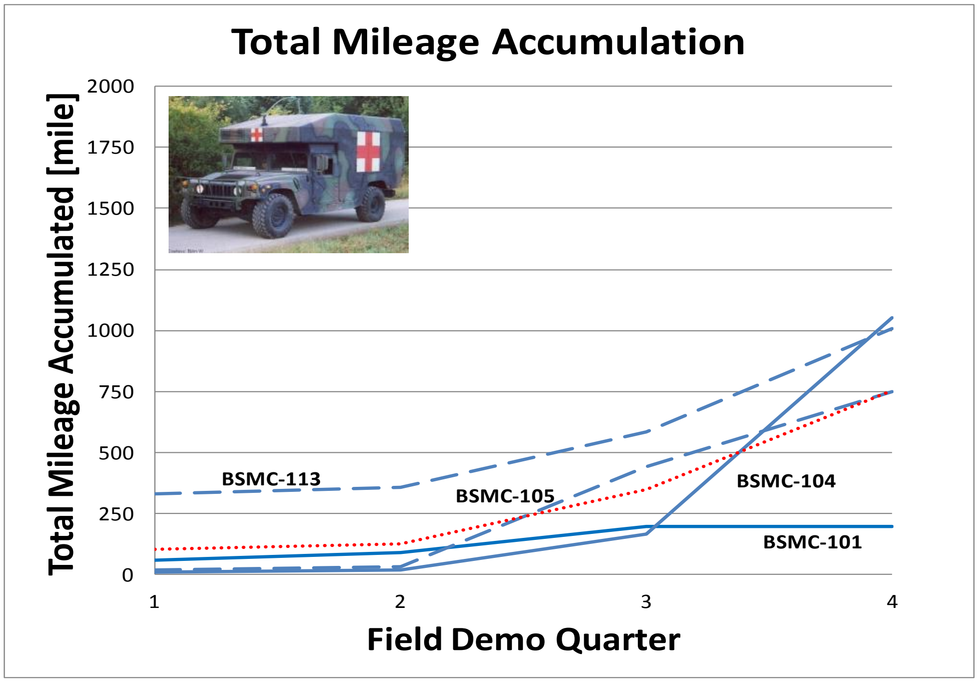

Figure 13. Ft. Wainwright, HMMWV Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

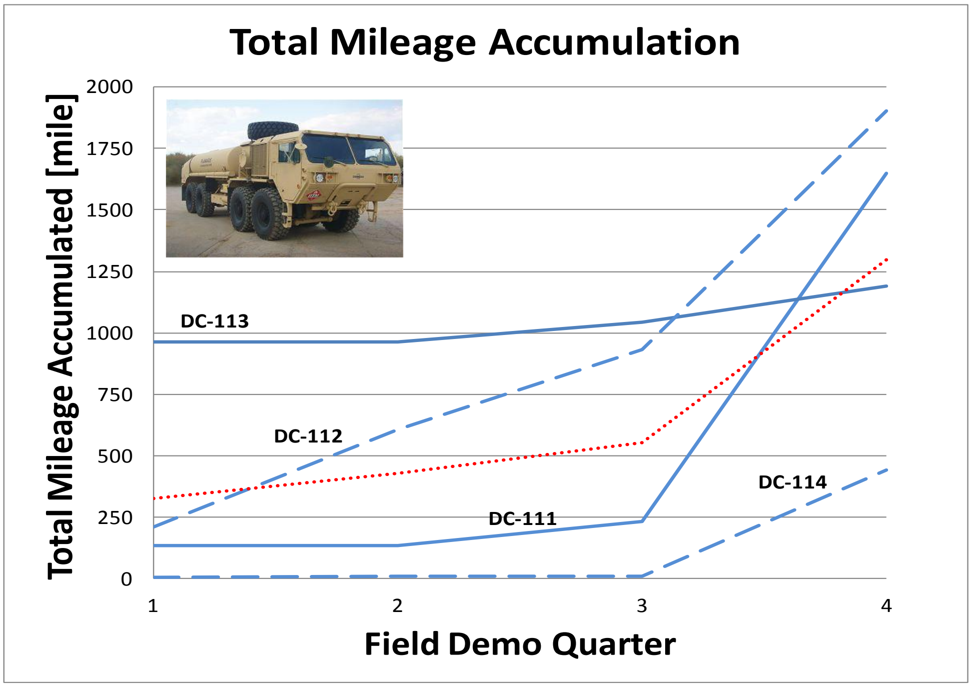

Figure 14. Ft. Wainwright, HEMTT Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

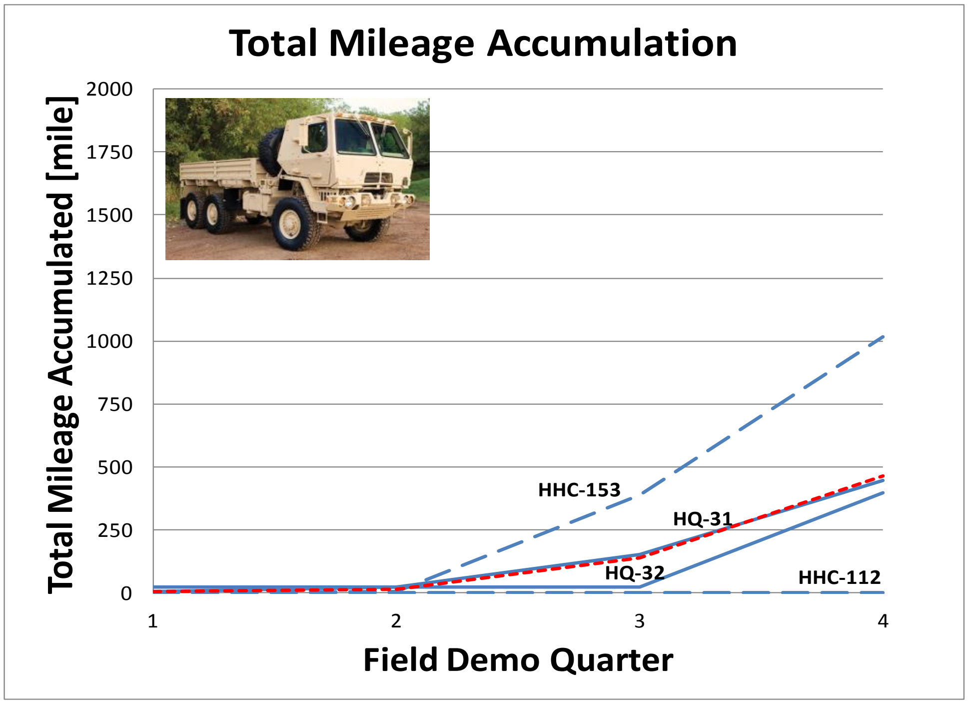

Figure 15. Ft. Wainwright, MTV Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

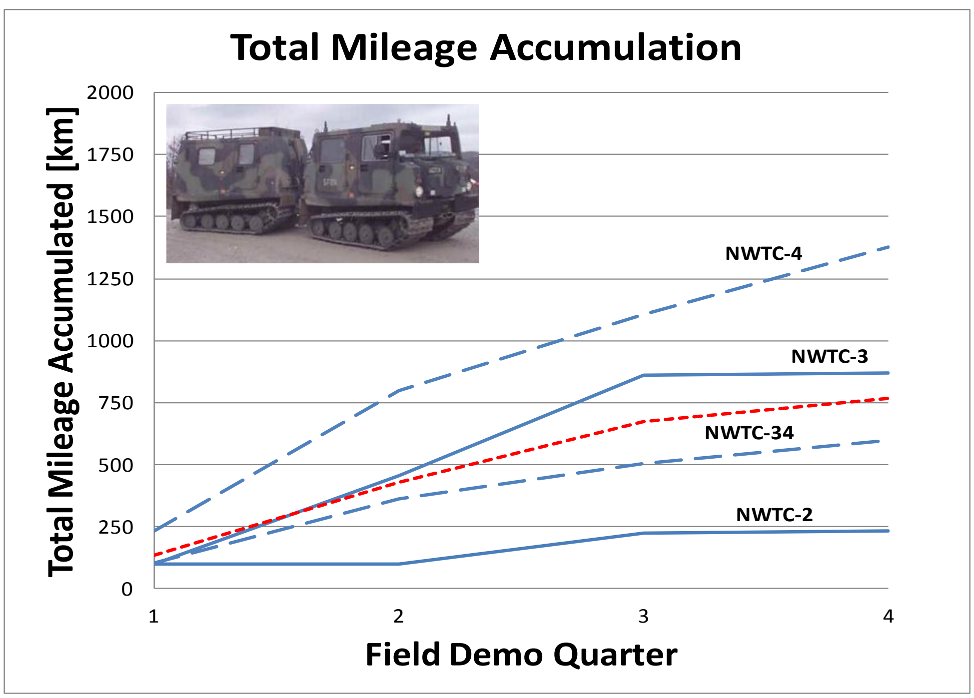

Figure 16. Ft. Wainwright, SUS-V Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

4.2.3 Oil Analysis

Used oil analysis conducted on quarterly samples is reported below, and is broken up by vehicle type. Comments and observations made from the data are listed in a bulleted format.

HMMWV (engine)

- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 17), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-46167 OEA-30 products.
- No issues were identified in typical wear metals (Fe, Cu, Pb, etc) that would suggest an incompatibility with the SCPL.

Table 21. Ft. Wainwright UOA, HMMWV Engine, TEST

TEST Engine			HMMWV BSCM101						HMMWV BSMC104					
			Miles	27213.5	27270.2	27302.7	27409.5	27411	Miles	26	35.4	46.2	193.5	1077
			Accum.	-	56.7	89.2	196	197.5	Accum.	-	9.4	20.2	167.5	1051
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR
Method	Property	Units		85.2%	% initial changeover (calculated from Mg)					94.7%	% initial changeover (calculated from Mg)			
D445 100c	Viscosity	cSt	9.87	8.67	8.46	8.89	8.92	8.7	10.11	8.75	8.78	9.02	8.98	9.36
D445 40c	Viscosity	cSt		47.62				47.82		47.28				52.33
D2270	Viscosity Index			162				162		167				164
D4739	TBN Buffer	mg KOH/g		9.18		8.56		IC		9.43		8.7		IC
D5185	Al	ppm	2	1	2	4	5	4	2	1	2	3	4	7
	Cu	ppm	<1	<1	<1	<1	1	2	2	3	1	2	2	5
	Fe	ppm	12	4	12	39	51	51	23	2	21	62	94	127
	Pb	ppm	4	<1	<1	3	4	6	4	<1	2	3	4	9
	Si	ppm	10	7	36	44	44	46	21	9	12	18	19	29
D664 Acid	TAN Buffer	mg KOH/g		1.74		1.83		1.89		1.73		1.52		2.35

Table 22. Ft. Wainwright UOA, HMMWV Engine, CONTROL

CONTROL Engine			HMMWV BSCM105						HMMWV BSMC113					
			Miles	17194.1	17212	17226	17633.5	17945	*Miles*	16080.4	16409	16439	16663.8	17088
			Accum.	-	17.9	31.9	439.4	750.9	*Accum.*	-	328.6	358.6	583.4	1007.6
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		10.3	*Sample Not Available*	10.04	9.83	9.72		9.64	*Sample Not Available*	9.74	9.31	9.57
D445 40c	Viscosity	cSt		56.74				54.57		52.93				54.44
D2270	Viscosity Index			172				165		169				161
D4739	TBN Buffer	mg KOH/g		8.78		7.2		7.24		9.58		8.65		6.92
D5185	Al	ppm		4		8	10	10		2		2	2	4
	Cu	ppm		2		4	5	5		<1		13	16	18
	Fe	ppm		33		79	138	113		5		20	34	47
	Pb	ppm		6		11	16	18		4		31	43	72
	Si	ppm		46		55	39	36		32		52	66	79
D664 Acid	TAN Buffer	mg KOH/g		2.13		2.46		2.92		2.28		2.3		2.55

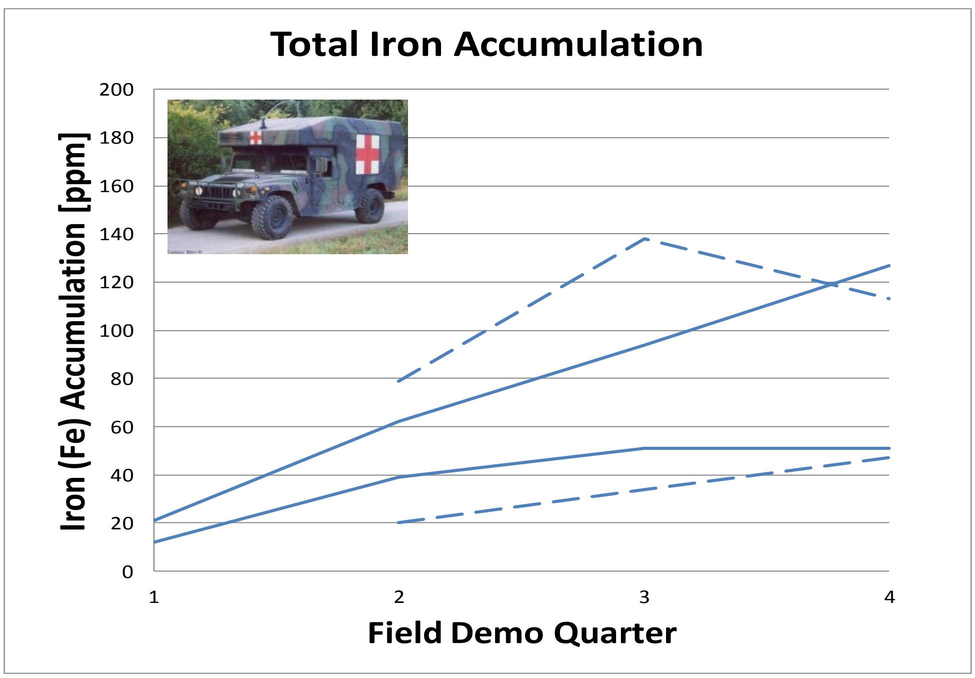

Figure 17. Ft. Wainwright UOA, HMMWV Engine, Iron Accumulation

Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

HMMWV (transmission)

- Consistent with the use of arctic oil in the HMMWV transmission, the SCPL was also evaluated in this component.
- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- No issues were identified in typical wear metals (Fe, Cu, Pb, etc) that would suggest an incompatibility with the SCPL.
- No operational issues were reported by maintenance personnel regarding the use of the SCPL in the transmissions that would suggest an incompatibility.

Table 23. Ft. Wainwright UOA, HMMWV Transmission, TEST

TEST Trans.			HMMWV BSCM101						HMMWV BSMC104					
			Miles	27213.5	27270.2	27302.7	27409.5	27411	*Miles*	26	35.4	46.2	193.5	1077
			Accum.	-	56.7	89.2	196	197.5	*Accum.*	-	9.4	20.2	167.5	1051
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units		58.6%	*% initial changeover (calculated from Mg)*					57.3%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	cSt	9.05	8.72	8.45	8.31	8.39	8.19	9.43	8.92	8.49	8.62	8.34	8.48
D445 40c	Viscosity	cSt		47.61				45.58		48.59				45.98
D2270	Viscosity Index			164				155		166				164
D4739	TBN Buffer	mg KOH/g		9.24		8.83		IC		9.22		9.11		IC
D5185	Al	ppm	1	<1	1	1	1	1	1	1	1	1	1	2
	Cu	ppm	10	4	5	5	5	5	10	<1	5	5	5	6
	Fe	ppm	5	3	3	4	4	3	4	7	3	4	4	4
	Pb	ppm	1	<1	<1	2	<1	2	1	<1	<1	<1	2	2
	Si	ppm	8	7	6	6	6	6	15	10	11	10	10	10
D664 Acid	TAN Buffer	mg KOH/g		1.71		1.84		1.89		1.74		1.88		1.77

Table 24. Ft. Wainwright UOA, HMMWV Transmission, CONTROL

CONTROL Trans.			HMMWV BSCM105						HMMWV BSMC113					
			Miles	17194.1	17212	17226	17633.5	17945	*Miles*	16080.4	16409	16439	16663.8	17088
			Accum.	-	17.9	31.9	439.4	750.9	*Accum.*	-	328.6	358.6	583.4	1007.6
			Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
			Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		8.17	*Sample Not Available*	7.97	7.74	7.52		9.45	*Sample Not Available*	8.65	8.52	8.37
D445 40c	Viscosity	cSt		42.84				40.9		50.67				44.69
D2270	Viscosity Index			168				153		173				166
D4739	TBN Buffer	mg KOH/g		6.08		5.67		8.3		9.33		8.26		8.77
D5185	Al	ppm		1		1	1	1		1		1	1	1
	Cu	ppm		14		16	18	19		14		19	17	22
	Fe	ppm		10		10	14	14		4		4	4	4
	Pb	ppm		9		10	11	11		2		3	4	5
	Si	ppm		9		8	9	9		14		14	14	15
D664 Acid	TAN Buffer	mg KOH/g		1.19		1.39		1.02		2.07		2.08		1.57

HEMTT (engine)

- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 18), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-46167 OEA-30 products.
- Consistent with that seen in the Ft. Benning data, HEMTT DC113 (TEST) and DC112 (CONTROL) exhibit elevated copper accumulation.
- HEMTT DC113 (TEST) received a necessary oil change between the 2nd and 3rd QTR. This was conducted as a precautionary measure, as this unit experienced a valve bridge failure which resulted in the misfiring of a single cylinder during engine operation. It was expected that fuel dilution could have occurred during troubleshooting of this problem. An analytical check showed 1.2 mass percent fuel dilution, a result slightly higher than expected. As such the oil was changed to ensure no contamination issues existed, and the engine was repaired and put back on test.
- No other issues were identified in regards to the wear metals that would suggest an incompatibility with the SCPL.

Table 25. Ft. Wainwright UOA, HEMTT Engine, TEST

TEST Engine			HEMTT DC111						HEMTT DC113					
			Miles	110.4	244.7	246.4	340.5	1757.9	Miles	398.5	1359.6	1359.7	1439.4	1588.1
			Accum.	-	134.3	136	230.1	1647.5	Accum.	-	961.1	961.2	1040.9	1189.6
			Hours	45.55	102.8	192.4	240.5	352.2	Hours	84.55	214.6	243.05	264.3	299.5
			Accum.	-	57.25	146.85	194.95	306.65	Accum.	-	130.05	158.5	179.75	214.95
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units		78.4%	*% initial changeover (calculated from Mg)*					78.2%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	cSt	8.72	8.65		8.53	8.07	8.29	7.64	8.83	8.35	7.94	8.19	7.82
D445 40c	Viscosity	cSt		46.19				44.81		48.21				41.66
D2270	Viscosity Index			168				163		165				161
D4739	TBN Buffer	mg KOH/g		9.83		8.29		6.42		9.66	8.41	6.54		6.79
D5185	Al	ppm	1	<1	2	2	2	3	1	1	2	3	3	4
	Cu	ppm	17	5	11	14	18	45	58	<1	27	201	85	96
	Fe	ppm	8	3	11	18	24	32	13	3	20	36	28	34
	Pb	ppm	<1	<1	<1	<1	2	2	2	<1	1	2	<1	<1
	Si	ppm	32	13	17	18	20	32	38	7	22	25	14	17
D664 Acid	TAN Buffer	mg KOH/g		1.6		1.82		2.17		1.74	2.02	1.79		1.86

Note: Bold vertical lines in between data columns indicate an oil change

Table 26. Ft. Wainwright UOA, HEMTT Engine, CONTROL

CONTROL Engine			HEMTT DC112						HEMTT DC114					
			Miles		306.3	705.3	1029.6	2001	*Miles*	423.2	430	431.3	431.5	866
			Accum.	-	306.3	705.3	1029.6	2001	*Accum.*	-	6.8	8.1	8.3	442.8
			Hours		102.3	218.25	335.65	419.8	*Hours*	77.1	84.3	137.1	143.6	196.9
			Accum.	-	102.3	218.25	335.65	419.8	*Accum.*	-	7.2	60	66.5	119.8
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		Initial Sample Not Available Vehicle Switch	8.46	8.5	8.14	9.16		8.62	8.37	8.5	7.96	8.31
D445 40c	Viscosity	cSt						52.35		44.56				44.82
D2270	Viscosity Index							158		175				163
D4739	TBN Buffer	mg KOH/g				7		6		9.4		8.61		7.36
D5185	Al	ppm			1	2	2	2		6	4	6	8	9
	Cu	ppm			34	162	269	429		9	12	17	19	36
	Fe	ppm			18	36	41	39		6	6	11	15	18
	Pb	ppm			3	4	4	4		<1	<1	1	1	2
	Si	ppm			44	47	48	45		25	28	31	32	41
D664 Acid	TAN Buffer	mg KOH/g				1.99		1.87		1.79		1.86		2.09

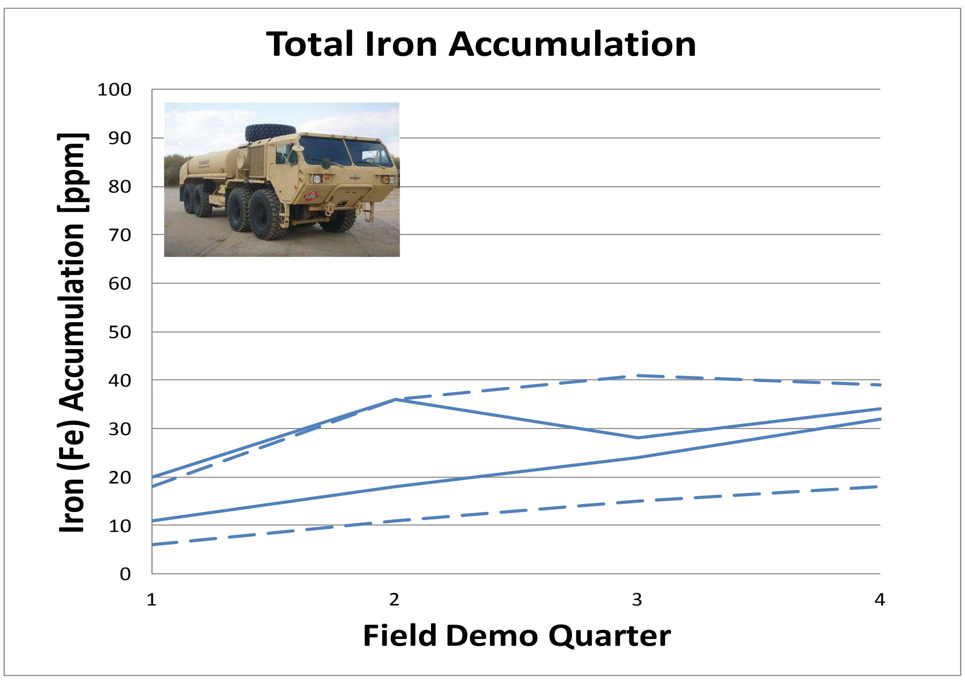

Figure 18. Ft. Wainwright UOA, HEMTT Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

HEMTT (transmission)

- Consistent with the use of arctic oil in the HEMTT transmission, the SCPL was also evaluated in this component.
- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- No issues were identified in typical wear metals (Fe, Cu, Pb, etc) that would suggest an incompatibility with the SCPL.
- No operational issues were reported by maintenance personnel regarding the use of the SCPL in the transmissions that would suggest an incompatibility.

Table 27. Ft. Wainwright UOA, HEMTT Transmission, TEST

TEST Trans.			HEMTT DC111						HEMTT DC113					
			Miles	110.4	244.7	246.4	340.5	1757.9	*Miles*	398.5	1359.6	1359.7	1439.4	1588.1
			Accum.	-	134.3	136	230.1	1647.5	*Accum.*	-	961.1	961.2	1040.9	1189.6
			Hours	45.55	102.8	192.4	240.5	352.2	*Hours*	84.55	214.6	243.05	264.3	299.5
			Accum.	-	57.25	146.85	194.95	306.65	*Accum.*	-	130.05	158.5	179.75	214.95
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units		84.8%	*% initial changeover (calculated from Mg)*					83.1%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	cSt	10.04	8.87	8.6	8.39	8.43	8.16	9.6	8.41	8.24	8.39	8.15	8.29
D445 40c	Viscosity	cSt		48.18				46.62		44.21				46.36
D2270	Viscosity Index			166				158		170				163
D4739	TBN Buffer	mg KOH/g		9.45		8.74		5.25		9.28		8.99		7.24
D5185	Al	ppm	2	<1	2	1	2	2	2	<1	3	3	3	3
	Cu	ppm	2	<1	1	1	2	2	2	12	1	2	2	2
	Fe	ppm	5	2	4	4	6	8	6	4	10	8	10	10
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
	Si	ppm	6	6	6	6	6	6	7	13	6	7	7	7
D664 Acid	TAN Buffer	mg KOH/g		1.56		1.52		1.71		1.61		1.82		1.72

Table 28. Ft. Wainwright UOA, HEMTT Transmission, CONTROL

CONTROL Trans.			HEMTT DC112						HEMTT DC114					
			Miles	0	306.3	705.3	1029.6	2001	*Miles*	423.2	430	431.3	431.5	866
			Accum.	-	306.3	705.3	1029.6	2001	*Accum.*	-	6.8	8.1	8.3	442.8
			Hours	0	102.3	218.25	335.65	419.8	*Hours*	77.1	84.3	137.1	143.6	196.9
			Accum.	-	102.3	218.25	335.65	419.8	*Accum.*	-	7.2	60	66.5	119.8
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		Initial Sample Not Available Vehicle Switch	9.53	9.15	8.77	8.51		9.56	9.26	8.91	9.02	8.83
D445 40c	Viscosity	cSt						49.13		52.99				48.96
D2270	Viscosity Index							151		167				162
D4739	TBN Buffer	mg KOH/g				7.92		8.56		10.08		8.98		8.76
D5185	Al	ppm			2	2	2	3		2	2	2	2	3
	Cu	ppm			4	6	6	5		<1	1	1	1	2
	Fe	ppm			5	8	8	10		4	4	4	4	6
	Pb	ppm			1	2	3	2		<1	<1	<1	<1	1
	Si	ppm			4	5	4	5		6	5	5	4	5
D664 Acid	TAN Buffer	mg KOH/g				1.83		2.1		2.13		2.28		2.14

SUS-V (engine)

- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 19), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-46167 OEA-30 products.
- Viscosity increase rates for the SUS-V's were observed to be higher compared to that of the other vehicles. This is attributed to higher soot accumulation in the SUS-V due to its indirect injection and mechanical fuel injection system, which typically generates higher soot levels in oils compared to more modern electronically controlled direct injected systems.
- No other issues were identified in regards to the wear metals that would suggest an incompatibility with the SCPL.

Table 29. Ft. Wainwright UOA, SUS-V Engine, TEST

TEST Engine			SUS-V NWTC2						SUS-V NWTC3					
			km	6988	7086	7086	7210	7220	*km*	4588	4656	5042	5449	5456
			Accum.	-	98	98	222	232	*Accum.*	-	68	454	861	868
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units		99.3%	*% initial changeover (calculated from Mg)*					94.9%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	cSt	10.42	8.75	9.01	9.41	9.55	9.45	14.05	8.93	9.61	10.14	10.52	10.02
D445 40c	Viscosity	cSt		46.94				55.29		50.57				59.25
D2270	Viscosity Index			168				155		158				156
D4739	TBN Buffer	mg KOH/g		9.62		7.44		8.24		8.55		6.79		9.04
D5185	Al	ppm	4	1	2	3	3	3	9	2	4	6	6	6
	Cu	ppm	2	<1	1	2	2	3	5	<1	2	3	3	4
	Fe	ppm	46	6	19	30	40	38	107	13	34	53	63	61
	Pb	ppm	<1	<1	<1	<1	<1	<1	2	<1	<1	1	1	<1
	Si	ppm	6	6	5	5	6	6	10	7	7	8	8	10
D664 Acid	TAN Buffer	mg KOH/g		1.7		1.92		2.17		1.86		2.04		2.35

Table 30. Ft. Wainwright UOA, SUS-V Engine, CONTROL

CONTROL Engine			SUS-V NWTC4						SUS-V NWTC34					
			km	4945	5179	5742	6052	6323	*km*	4157	4260	4517	4661	4754
			Accum.	-	234	797	1107	1378	*Accum.*	-	103	360	504	597
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		7.93	9.2	12.2	13.06	12.2		10.38	10.05	10.57	10.7	11.27
D445 40c	Viscosity	cSt		38.58				84.6		59.2				72.14
D2270	Viscosity Index			184				139		166				148
D4739	TBN Buffer	mg KOH/g		7.79		6.48		7.94		7.11		6.67		8.76
D5185	Al	ppm		9	10	9	8	7		8	6	6	7	6
	Cu	ppm		4	5	4	4	3		5	6	4	4	4
	Fe	ppm		48	60	71	73	60		56	50	60	68	55
	Pb	ppm		5	5	3	2	2		<1	1	<1	1	<1
	Si	ppm		16	16	14	13	11		12	11	11	12	10
D664 Acid	TAN Buffer	mg KOH/g		1.71		2.07		2.38		1.93		1.9		1.92

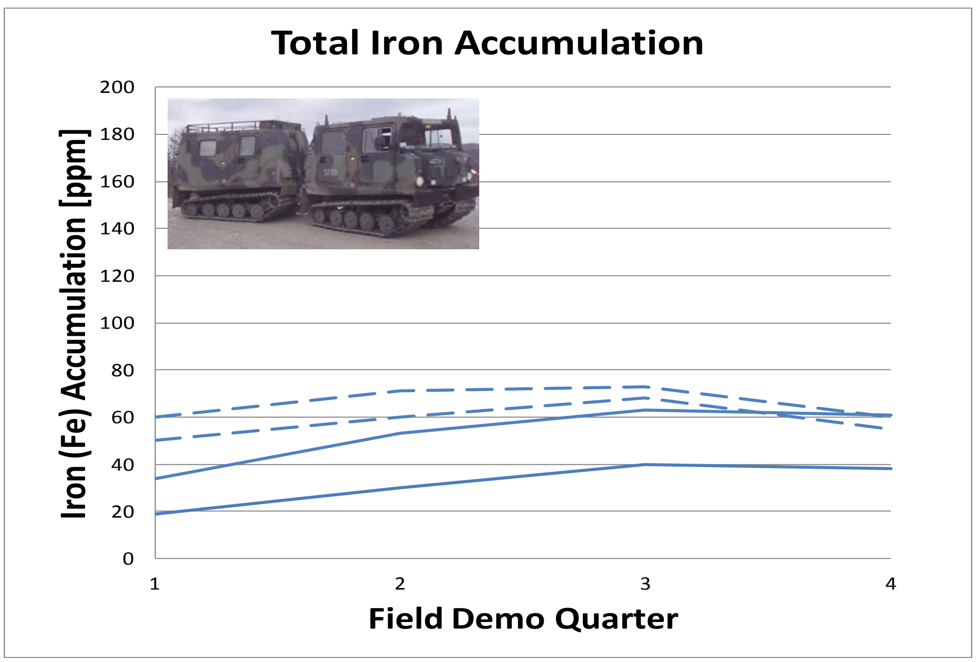

Figure 19. Ft. Wainwright UOA, SUS-V Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

MTV (engine)

- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 20), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-46167 OEA-30 products.
- No issues were identified in typical wear metals (Fe, Cu, Pb, etc) that would suggest an incompatibility with the SCPL.

Table 31. Ft. Wainwright UOA, MTV Engine, TEST

TEST Engine			MTV HQ31						MTV HQ32					
			Miles	1883	1904	1908	2033	2327	*Miles*	756	762	777	778	1155
			Accum.	-	21	25	150	444	*Accum.*	-	6	21	22	399
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units		85.2%	*% initial changeover (calculated from Mg)*					94.7%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	cSt	8.99	8.69	8.28	8.34	8.27	8.21	9.23	8.57	8.34	8.28	8.26	8.16
D445 40c	Viscosity	cSt		46.16				44.39		46.83				44.92
D2270	Viscosity Index			170				162		163				157
D4739	TBN Buffer	mg KOH/g		9.14		9.11		5.3		9.37		9.1		7.52
D5185	Al	ppm	2	<1	2	1	2	2	2	1	2	1	2	2
	Cu	ppm	17	4	6	8	7	8	7	<1	3	2	3	4
	Fe	ppm	12	4	6	8	11	14	6	2	3	5	5	8
	Pb	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Si	ppm	14	8	8	7	7	9	12	7	6	7	7	9
D664 Acid	TAN Buffer	mg KOH/g		1.77		1.67		1.9		1.75		1.28		1.73

Table 32. Ft. Wainwright UOA, MTV Engine, CONTROL

CONTROL Engine			MTV HHC111 (153)						MTV HHC112					
			Miles	5328.1	5328.5	5335	5335	6344.5	*Miles*	6985.6	6986.2	6986.2	6986	6986.2
			Accum.	-	0.4	6.9	6.9	1016.4	*Accum.*	-	0.6	0.6	0.4	0.6
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	Property	Units												
D445 100c	Viscosity	cSt		9.2	8.64	9.11	8.3	8.37		9.21	9.01	9.07	8.9	8.8
D445 40c	Viscosity	cSt		49.01				45.17		50.08				49.07
D2270	Viscosity Index			173				164		168				160
D4739	TBN Buffer	mg KOH/g		10.09		9.43		7.99		9.74		8.9		8.01
D5185	Al	ppm		1	1	1	2	2		2	1	2	1	1
	Cu	ppm		2	7	<1	3	4		2	3	3	3	8
	Fe	ppm		5	6	7	11	21		6	5	6	6	6
	Pb	ppm		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Si	ppm		5	4	5	5	6		5	4	4	4	4
D664 Acid	TAN Buffer	mg KOH/g		2.35		2.44		2.68		2.28		2.18		2.23

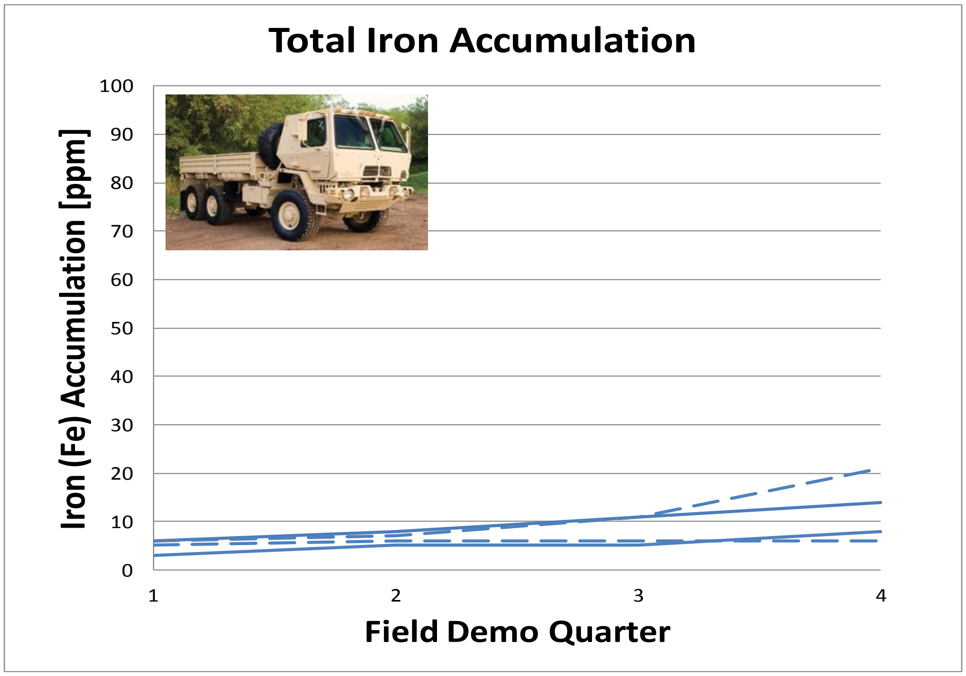

Figure 20. Ft. Wainwright UOA, MTV Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

MTV (transmission)

- Consistent with the use of arctic oil in the HEMTT transmission, the SCPL was also evaluated in this component.
- Little differences in used oil analysis between the TEST and CONTROL vehicles exist.
- Consistent with the Ft. Benning data, higher levels of copper (Cu) accumulation were observed in both the TEST and CONTROL MTV transmissions. The source of this copper is unknown, but as found samples removed from the vehicles at the start of testing also showed high copper levels. This combined with Ft. Bliss results suggests that copper accumulation is likely normal for this type transmission.
- No other issues were identified in typical wear metals that would suggest an incompatibility with the SCPL.
- No operational issues were reported by maintenance personnel regarding the use of the SCPL in the transmissions.

Table 33. Ft. Wainwright UOA, MTV Transmission, TEST

TEST Trans.			MTV HQ31						MTV HQ32					
			Miles	1883	1904	1908	2033	2327	*Miles*	756	762	777	778	1155
			Accum.	-	21	25	150	444	*Accum.*	-	6	21	22	399
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	**Property**	**Units**		58.6%	*% initial changeover (calculated from Mg)*					57.3%	*% initial changeover (calculated from Mg)*			
D445 100c	**Viscosity**	**cSt**	9.04	8.65	8.19	8.12	8.03	7.86	8.88	8.49	8.21	8.36	8.18	8.28
D445 40c	**Viscosity**	**cSt**		45.44				43.6		44.46				43.99
D2270	**Viscosity Index**			172				172		171				166
D4739	**TBN Buffer**	**mg KOH/g**		9.06		8.54		8.5		8.51		8.05		8.96
D5185	**Al**	**ppm**	2	1	2	2	2	2	3	2	2	2	2	2
	Cu	**ppm**	113	68	51	57	58	55	202	116	99	97	96	110
	Fe	**ppm**	12	7	6	8	9	10	19	10	8	11	11	12
	Pb	**ppm**	4	1	<1	1	2	2	4	2	1	2	2	2
	Si	**ppm**	29	8	6	8	8	7	19	10	8	9	10	10
D664 Acid	**TAN Buffer**	**mg KOH/g**		1.6		1.7		1.58		1.45		1.52		1.36

Table 34. Ft. Wainwright UOA, MTV Transmission, CONTROL

CONTROL Trans.			MTV HHC111 (153)						MTV HHC112					
			Miles	5328.1	5328.5	5335	5335	6344.5	*Miles*	6985.6	6986.2	6986.2	6986	6986.2
			Accum.	-	0.4	6.9	6.9	1016.4	*Accum.*	-	0.6	0.6	0.4	0.6
			-	-	-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Method	**Property**	**Units**												
D445 100c	**Viscosity**	**cSt**		9.52	8.88	8.85	8.78	8.45		9.11	8.8	8.96	8.74	8.9
D445 40c	**Viscosity**	**cSt**		55.1				49.62		50.41				50.13
D2270	**Viscosity Index**			157				147		164				159
D4739	**TBN Buffer**	**mg KOH/g**		8.43		8.26		8.52		8.94		8.26		8.02
D5185	**Al**	**ppm**		3	3	3	4	4		3	2	3	3	3
	Cu	**ppm**		467	532	546	550	677		332	394	399	368	422
	Fe	**ppm**		24	21	21	26	27		17	15	15	18	18
	Pb	**ppm**		2	2	2	2	2		3	4	3	3	3
	Si	**ppm**		8	8	8	8	7		20	7	6	8	8
D664 Acid	**TAN Buffer**	**mg KOH/g**		1.43		1.63		1.63		1.45		1.79		1.85

4.3 DESERT CLIMATE – FT. BLISS TX

For the desert climate location, a total fleet of 21 vehicles were identified and included in the field demonstration. The 21 vehicle fleet consisted of 14 TEST vehicles and 7 CONTROL vehicles. Table 35 outlines the basic climate vehicle fleet indicating vehicle type, description, model number, TEST/CONTROL designation, and its identification (bumper) number. As previously discussed, the Ft. Bliss field demonstration was the only location to evaluate both SCPL candidates. Table 35 also notates which SCPL oil was used in each vehicle.

Table 35. Ft. Bliss Desert Climate Vehicle Fleet

Vehicle Type	Description	Model	TEST/CONTROL	Bumper No.	SCPL Candidate
M88	Tracked Recovery Vehicle	M88A2	TEST	E319	OIL A
			TEST	F864	OIL B
			CONTROL	E317	-
			CONTROL	F861	-
Bradley	Armored Fighting Vehicle (Tracked)	M3A3	TEST	A11*	OIL A
			TEST	B23*	OIL A
			TEST	HQ33*	OIL B
			TEST	B13*	OIL B
			CONTROL	B21	-
			CONTROL	B22	-
M-ATV	MRAP All Terrain Vehicle	M-ATV	TEST	D11N	OIL A
			TEST	D23	OIL A
			TEST	D13	OIL A
			TEST	D14N	OIL B
			TEST	D24	OIL B
			TEST	D22	OIL B
			CONTROL	D12	-
			CONTROL	D21N	-
MAXX PRO	MRAP	-	TEST	C107	OIL A
			TEST	HQ582	OIL B
			CONTROL	HQ581	-
* Denotes vehicles transmission included in SCPL evaluation					

4.3.1 Problem Areas – Ft. Bliss

The largest problem areas observed in at the Ft. Bliss location revolved around coordination of TFLRF activities around 2-1AD's mission activities. At many times vehicle access was limited, and vehicle scheduling between the three supporting battalions conflicted, preventing as rigorous and consistent data collection as desired by TFLRF. Despite this, every effort was made to reduce the field demo impact on the unit while still allowing the required data collection to occur. This included late addition of select control vehicles due to initial vehicle availability, and used oil sampling being skipped during the 3rd QTR after collection of mileage accumulation info that did not warrant the coordination and disruption of unit schedules.

Similar to the two previous locations, oil and fuel consumption data again was unable to be effectively collected. Like the previous two locations, oil and fuel consumption data for the SCPL is much better served by the laboratory testing conducted in the SCPL development phases of the program [1,2,3], where conditions were controlled tightly enough to determine actual changes.

Unlike the Ft. Benning field demonstration, the administration of the AOAP sampling program for Ft. Bliss was much improved. This was attributed to Ft. Bliss having an AOAP lab on post, which allowed closer coordination between AOAP lab staff, the units involved, and TFLRF.

4.3.2 Mileage Accumulation

Overall mileage accumulation of each vehicle type is shown graphically in the following plots. For all plots the solid blue lines represent the TEST vehicle mileage, the dashed blue lines represent the CONTROL vehicle mileage, and red dashed line represents the average mileage for the vehicle type as a whole. Full tabular mileage recordings for all vehicles are presented in the appendix, and includes by quarter, the mileage recordings, quarterly accumulation, and accumulation since start of test. In general, TEST versus CONTROL vehicle mileage comparable, apart from a few outliers (ex: Bradley B13). Most of the Ft. Bliss vehicle utilization was attributed to field activities completed by the units during the field demonstration, where as vehicles tended to be more idle after returning to the motor pools. Incidental usage of the equipment apart from field maneuvers was very low.

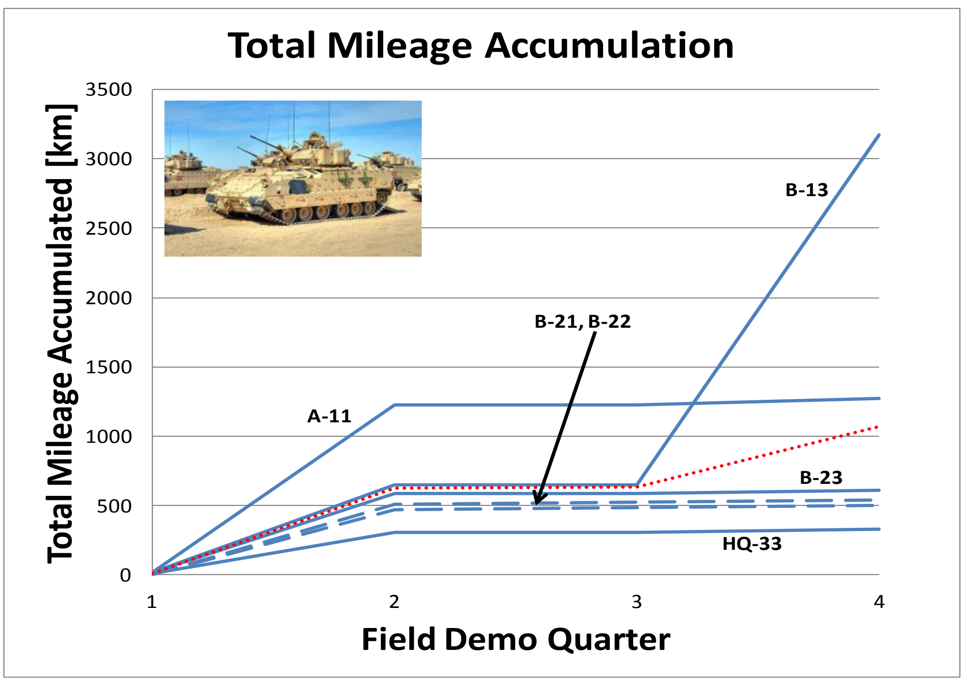

Figure 21. Ft. Bliss, Bradley Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

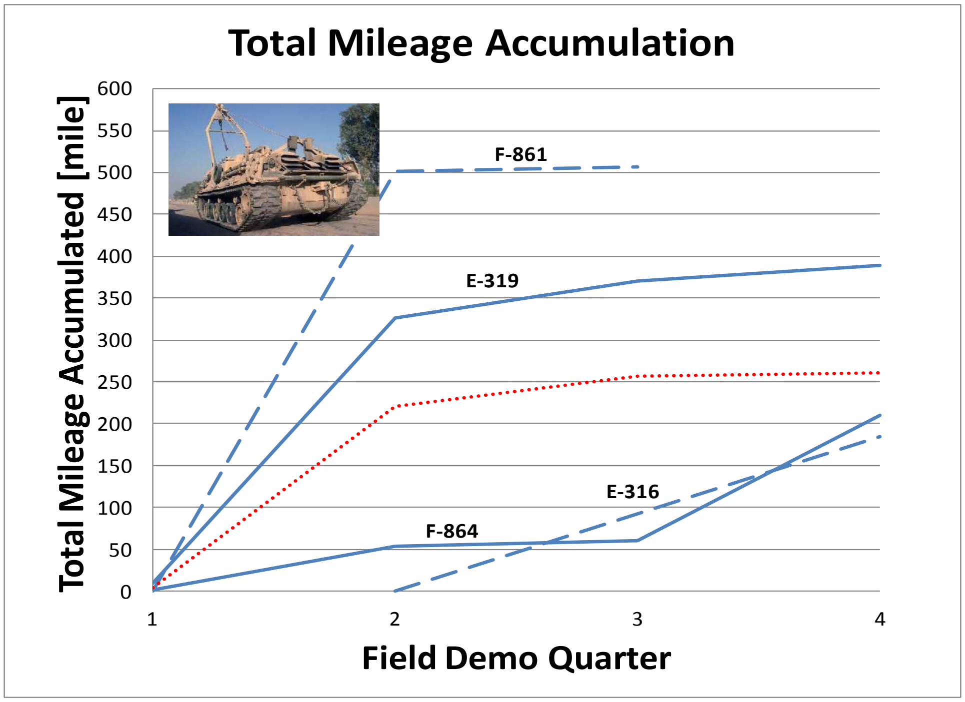

Figure 22. Ft. Bliss, M88A2 Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

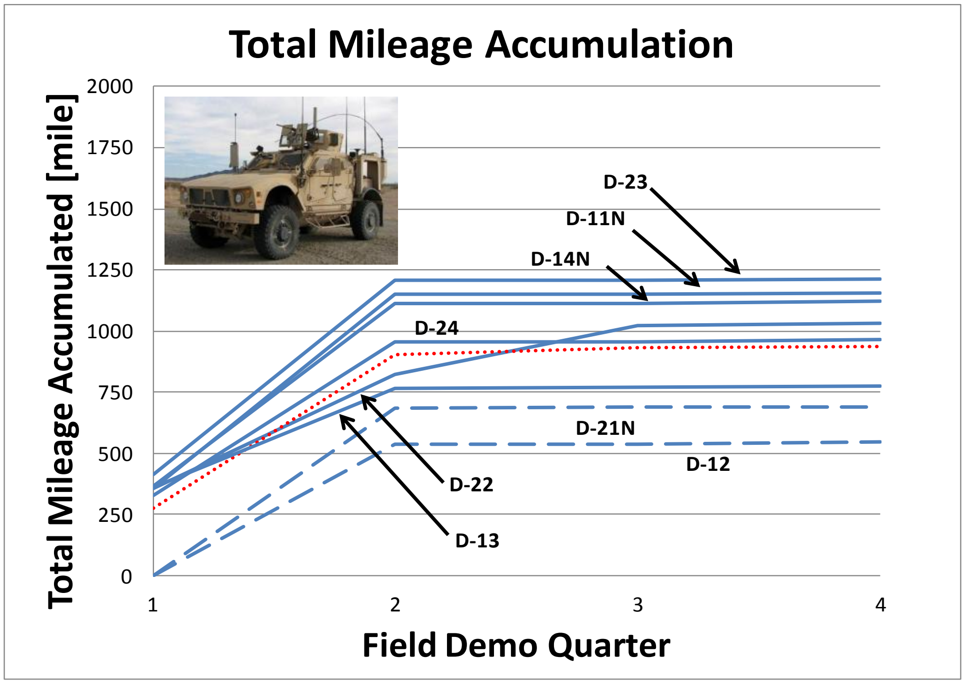

Figure 23. Ft. Bliss, MATV Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

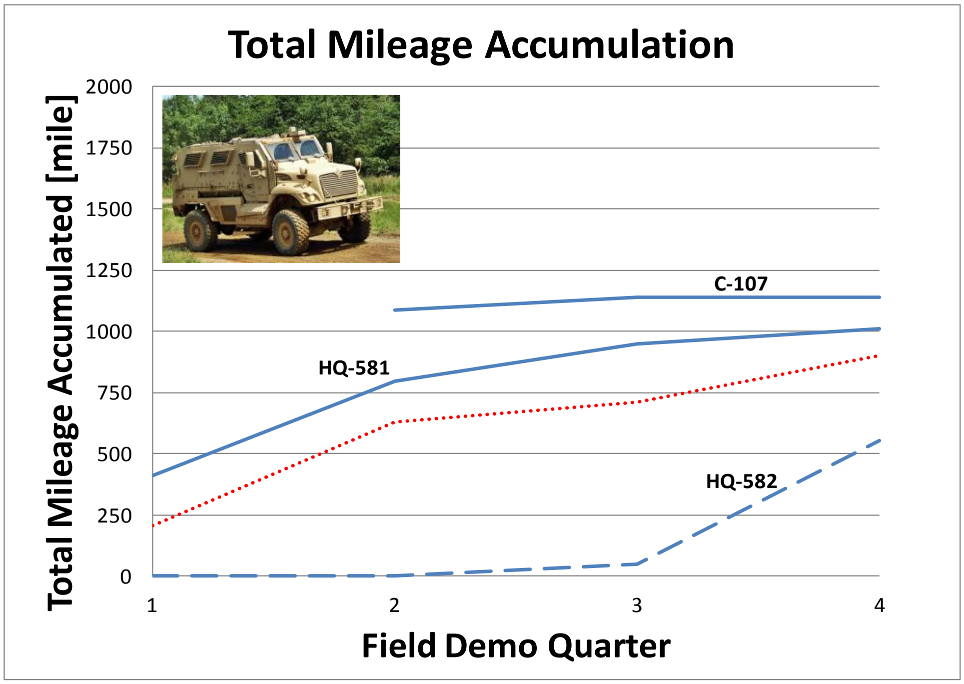

Figure 24. Ft. Bliss, MaxxPRO Mileage Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

4.3.3 Used Oil Analysis

Used oil analysis conducted on quarterly samples is reported below, and is broken up by vehicle type. Comments and observations made from the data are listed in a bulleted format.

M88A2 (engine)

- Little difference in used oil analysis between the TEST and CONTROL vehicles exist.
- E319 (TEST) received a necessary oil change after the completion of the 2nd quarter due to high levels of silicon. Silicon accumulation was attributed to dirt ingestion, which is common for this vehicle type. Iron levels were also rapidly increasing, suggesting that increased abrasive wear was occurring from the dirt contamination. The "as found" sample revealed similarly high silicon levels, which suggest that there was a pre-existing fault in the air filtration system of this unit.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 25), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products (excluding E319 based on the previous comment)

- Beyond the silicon accumulation in E319 (TEST), no appreciable differences were noted between SCPL OIL A and OIL B formulation.
- No other significant source of wear metals were identified in the M88A2 vehicles that would suggest an incompatibility with the SCPL.

Table 36. Ft. Bliss UOA, M88A1/A2 Engine, TEST

TEST Engine			M88A2 E319					M88A2 F864				
			SCPL OIL A					SCPL OIL B				
			Miles	1502.1	1511.8	1828	1891.01	*Miles*	29.5	35	83.9	240
			Accum.	-	9.7	325.9	388.91	*Accum.*	-	5.5	54.4	210.5
			Hours	Non functioning				*Hours*	80.5	83	38.4	62.9
			Accum.					*Accum.*	-	2.5	-	62.9
			As found	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units										
D445 100c	Viscosity	cSt		9.7	9.39	10.49	8.62		9.36	9.18	9.2	9.88
D445 40c	Viscosity	cSt		56.18		64			52.7			55.45
D2270	Viscosity Index			158		153			162			166
D4739	TBN Buffer	mg KOH/g		8.38		7.29	7.5		9.15		9.53	6.94
D5185	Al	ppm	59	16	18	96	33	5	4	4	5	8
	Cu	ppm	40	10	12	31	14	13	3	4	5	12
	Fe	ppm	218	56	72	282	101	27	8	13	12	36
	Pb	ppm	7	2	2	6	2	2	<1	<1	<1	3
	Si	ppm	116	36	40	241	79	42	15	21	26	37
D664 Acid	TAN Buffer	mg KOH/g		2.31		3	2.15		2.68			3.23

Note: Bold vertical lines in between data columns indicate an oil change

Table 37. Ft. Bliss UOA, M88A1/A2 Engine, CONTROL

CONTROL Engine			M88A2 E316					M88A2 F861				
			Miles	-	-	825.4	1010	*Miles*	N/A	323.3	N/A	483.3
			Accum.	-	-	-	184.6	*Accum.*	-	-	-	160
			Hours	-	-	Non Functioning		*Hours*	-	27.2	Tach Removed	
			Accum.	-	-			*Accum.*	-	-		
				Initial	*1st QTR*	*2nd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units		Sample Not Availble					Sample Not Available			
D445 100c	Viscosity	cSt				14.4	13.33			12.55	12.8	11.36
D445 40c	Viscosity	cSt				108.23	96.83			88.76		76.34
D2270	Viscosity Index					136	137			138		140
D4739	TBN Buffer	mg KOH/g				7.15	6.37			7.65		6.6
D5185	Al	ppm				11	21			7	8	15
	Cu	ppm				9	19			6	8	13
	Fe	ppm				36	69			22	28	59
	Pb	ppm				4	6			2	2	4
	Si	ppm				53	73			45	55	62
D664 Acid	TAN Buffer	mg KOH/g				2.55	2.73			1.74		2.19

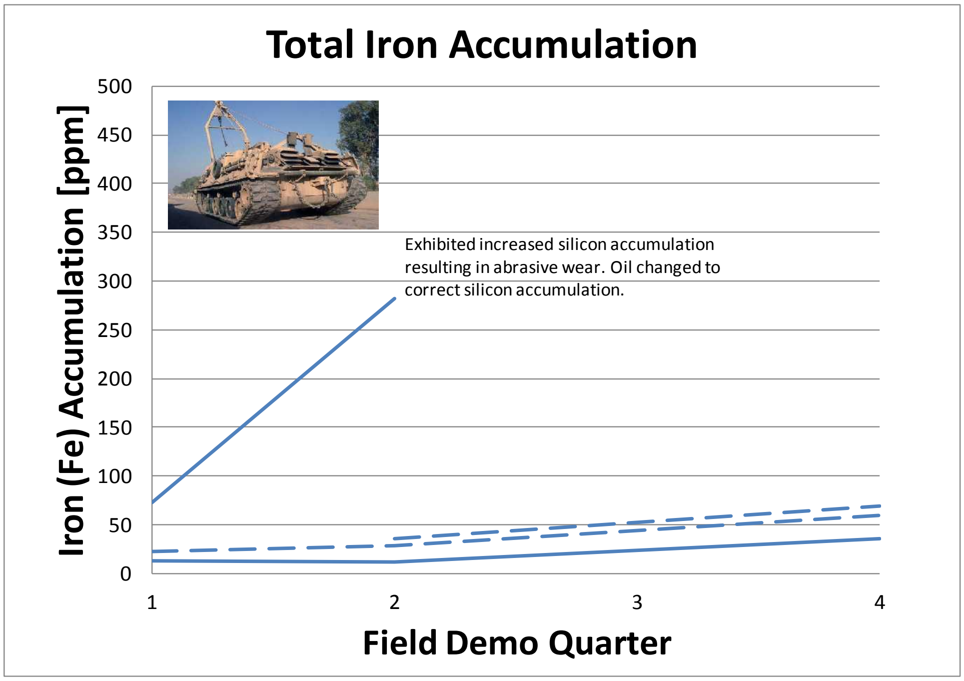

Figure 25. Ft. Bliss UOA, M88A1/A2 Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

Bradley (engine)

- Little difference in used oil analysis between the TEST and CONTROL vehicles exist.
- Bradley B22 (CONTROL) received an AOAP directed oil change between the 1st and 2nd QTR.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 26), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- No appreciable differences were noted between SCPL OIL A and OIL B formulations.
- No significant source of wear metals were identified in the BRADLEY vehicles that would suggest an incompatibility with the SCPL.

Table 38. Ft. Bliss UOA, Bradley Engine, TEST

TEST Engine			BRADLEY A11					BRADLEY B23				
			SCPL OIL A					SCPL OIL A				
			Miles	3685	3699	4912	4953	*Miles*	3491	3504	4073	4103
			Accum.	-	14	1227	1268	*Accum.*	-	13	582	612
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units										
D445 100c	Viscosity	cSt		9.7	9.21	9.31	9.38		9.5	9.38	8.44	8.69
D445 40c	Viscosity	cSt		56.36			52.91		53.93			46.15
D2270	Viscosity Index			158			162		161			170
D4739	TBN Buffer	mg KOH/g		9.06		7.32	6.85		8.52		7.88	7.06
D5185	Al	ppm	2	1	1	2	2	4	2	2	3	3
	Cu	ppm	10	3	5	11	11	42	10	11	7	7
	Fe	ppm	11	4	11	32	31	45	12	14	16	17
	Pb	ppm	2	<1	2	7	6	9	2	2	5	4
	Si	ppm	9	7	11	13	12	8	7	6	6	6
D664 Acid	TAN Buffer	mg KOH/g		1.95			2.09		2.06			2.19

TEST Engine			BRADLEY HQ33					BRADLEY B13				
			SCPL OIL B					SCPL OIL B				
			Miles	1433	1445	1736	1765	*Miles*	2159	2177	2809	5335
			Accum.	-	12	303	332	*Accum.*	-	18	650	3176
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
			As found	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units										
D445 100c	Viscosity	cSt		9.42	9.55	9.24	9.12		9.36	9.17	8.22	8.19
D445 40c	Viscosity	cSt		52.98			47.18		51.6			42.87
D2270	Viscosity Index			163			179		166			169
D4739	TBN Buffer	mg KOH/g		8.76		8.29	8.03		8.62		5.87	5.56
D5185	Al	ppm	3	3	3	4	4	5	4	3	5	6
	Cu	ppm	40	9	9	9	7	57	13	12	27	26
	Fe	ppm	33	9	10	14	13	42	11	12	28	28
	Pb	ppm	6	<1	1	2	3	10	3	3	13	12
	Si	ppm	8	7	6	6	6	13	8	6	7	8
D664 Acid	TAN Buffer	mg KOH/g		2.82			3.09		2.54			3.1

Table 39. Ft. Bliss UOA, Bradley Engine, CONTROL

CONTROL Engine			BRADLEY B21					BRADLEY B22				
			Miles	N/A	4132	4637	4671	*Miles*	N/A	3589	4057	4090
			Accum.	-	-	505	539	*Accum.*	-	-	468	501
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units		Sample Not Availble					Sample Not Availble			
D445 100c	Viscosity	cSt			13.9	13.43	13.42			12.65	14.5	13.75
D445 40c	Viscosity	cSt			102.89							
D2270	Viscosity Index				136							
D4739	TBN Buffer	mg KOH/g			6.33							
D5185	Al	ppm			3	4	4			4	2	2
	Cu	ppm			13	19	23			30	7	8
	Fe	ppm			25	41	45			75	24	24
	Pb	ppm			5	9	10			17	4	5
	Si	ppm			17	20	20			11	7	5
D664 Acid	TAN Buffer	mg KOH/g			2.43		2.46					

Note: Bold vertical lines in between data columns indicate an oil change

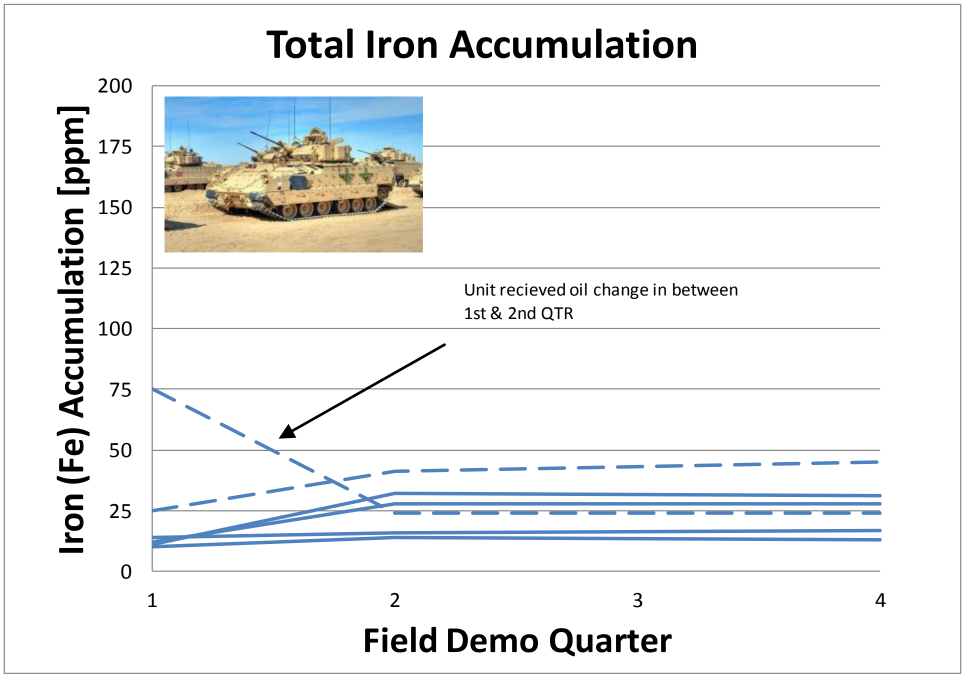

Figure 26. Ft. Bliss UOA, Bradley Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

<u>Bradley (transmission)</u>

- Wear metal analysis does not show significant accumulation of iron (Fe), lead (Pb), or copper (Cu). All levels were within established AOAP limits for this transmission model.
- Consistent with observations in the Ft. Benning data, some cadmium (Ca) accumulation was observed in the transmission sample.
    - This is observed in both TEST and CONTROL vehicles.
    - Source is unknown, but considered typical for the component based on observations from all field demo locations, and likely attributed to an internal component coating.
- No appreciable differences were noted between SCPL OIL A and OIL B formulations.
- No other issues identified that would suggest an incompatibility with the SCPL.
- No operational issues were reported by maintenance personnel regarding the use of the SCPL in the Bradley transmission.

Table 40. Ft. Bliss UOA, Bradley Transmission, TEST

TEST Trans.			BRADLEY A11					BRADLEY B23				
			SCPL OIL A					SCPL OIL A				
			Miles	3685	3699	4912	4953	Miles	3491	3504	4073	4103
			Accum.	-	14	1227	1268	Accum.	-	13	582	612
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR
Method	Property	Units										
D445 100c	Viscosity	cSt		9.19	8.56	8.22	8.39		9.77	8.77	8.36	8.58
D445 40c	Viscosity	cSt		51.68			45.6		47.16			47.84
D2270	Viscosity Index			161			162		199			158
D4739	TBN Buffer	mg KOH/g		9.51		9.14	8.38		9.51		8.97	8.02
D5185	Al	ppm	3	2	2	13	14	54	4	10	18	20
	Cu	ppm	36	6	39	117	128	872	52	178	271	305
	Fe	ppm	9	3	4	31	34	62	5	12	22	25
	Pb	ppm	4	<1	6	11	13	11	<1	2	4	5
	Si	ppm	11	7	7	11	12	48	8	14	19	18
	Cd	ppm	6	<1	5	22	27	20	1	6	18	22
D664 Acid	TAN Buffer	mg KOH/g		1.93			1.76		1.87			1.75

TEST Trans.			BRADLEY HQ33					BRADLEY B13				
			SCPL OIL B					SCPL OIL B				
			Miles	1433	1445	1736	1765	Miles	2159	2177	2809	5335
			Accum.	-	12	303	332	Accum.	-	18	650	3176
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR
Method	Property	Units										
D445 100c	Viscosity	cSt		8.96	9.06	9.02	8.72		8.79	8.84	8.64	9.05
D445 40c	Viscosity	cSt		48.02			50.02		47.07			47.32
D2270	Viscosity Index			170			154		169			176
D4739	TBN Buffer	mg KOH/g		9.44		9.45	8.57		9.52		9.59	8.6
D5185	Al	ppm	27	6	8	12	12	19	5	6	13	13
	Cu	ppm	644	81	129	145	156	745	63	136	266	289
	Fe	ppm	38	7	10	13	15	44	6	8	16	18
	Pb	ppm	40	5	10	14	16	21	2	5	13	18
	Si	ppm	49	12	13	15	15	27	8	8	10	10
	Cd	ppm	35	4	8	11	12	38	3	8	16	18
D664 Acid	TAN Buffer	mg KOH/g		2.6			2.53		2.41			2.15

Table 41. Ft. Bliss UOA, Bradley Transmission, CONTROL

CONTROL Trans.			BRADLEY B21					BRADLEY B22				
			Miles	N/A	4132	4637	4671	Miles	N/A	3589	4057	4090
			Accum.	-	-	505	539	Accum.	-	-	468	501
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
				Initial	1st QTR	2nd QTR	4th QTR		Initial	1st QTR	2nd QTR	4th QTR
Method	Property	Units		Sample Not Availble					Sample Not Availble			
D445 100c	Viscosity	cSt			10.58	10.73	10.72			12.67	11.99	11.99
D445 40c	Viscosity	cSt			76.48		76.4			93.56		87.22
D2270	Viscosity Index				124		127			131		130
D4739	TBN Buffer	mg KOH/g			6.12		5.76			7.63		7.3
D5185	Al	ppm			39	42	42			7	14	14
	Cu	ppm			712	738	806			138	230	248
	Fe	ppm			59	60	68			17	28	32
	Pb	ppm			28	28	29			6	8	8
	Si	ppm			54	57	57			9	12	12
	Cd				28	27	28			11	18	20
D664 Acid	TAN Buffer				1.53		1.55			1.88		1.92

MATV (engine)

- Little difference in used oil analysis between the TEST and CONTROL vehicles exist.
- Utilization of the vehicles was high during the first two quarters, but vehicles were idle throughout the remainder of the demo. As such, used oil analysis trends show the most change in the first two quarters, and then appear to flat line consistent with the lack of usage for the 3rd and 4th QTR.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 27), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- As observed in the HEMTT vehicles in Ft. Benning and Ft. Bliss, the MATV's, which use an engine of the same manufacturer of the HEMTT A4's, also show copper accumulation to varying degrees in the oil.
- No appreciable differences were noted between SCPL OIL A and OIL B formulations.
- No other significant source of wear metals were identified in the MATV vehicles that would suggest an incompatibility with the SCPL.

Table 42. Ft. Bliss UOA, MATV Engine, TEST

TEST Engine			MATV D11N					MATV D23					MATV D13				
			SCPL OIL A					SCPL OIL A					SCPL OIL A				
			Miles	2757.5	3117.3	3907.8	3914.8	*Miles*	3828.8	4243.7	5035	5042.3	*Miles*	3902.7	4266.5	4671.2	4677.9
			Accum.	-	359.8	1150.3	1157.3	*Accum.*	-	414.9	1206.2	1213.5	*Accum.*	-	363.8	1913.7	1920.4
			Hours	1502.7	1667.9	2193.6	2199.3	*Hours*	845.6	975.7	1372.1	1375.4	*Hours*	1377.1	1516.5	1911.7	1916.3
			Accum.	-	165.2	690.9	696.6	*Accum.*	-	130.1	526.5	529.8	*Accum.*	-	139.4	534.6	539.2
			As found	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units															
D445 100c	Viscosity	cSt		8.95	8.76	8.87	9.08		8.93	8.94	8.79	9.05		9.26	9.15	9.13	9.28
D445 40c	Viscosity	cSt		49.59			51.14		49.59			50.34		49.99			52.37
D2270	Viscosity Index			163			160		162			162		170			161
D4739	TBN Buffer	mg KOH/g		8.69		6.67	6.13		8.92		7.61	6.81		9		7.23	6.3
D5185	Al	ppm	4	2	2	4	4	6	2	2	3	3	4	2	3	4	4
	Cu	ppm	608	86	140	162	169	673	97	143	174	175	372	48	86	108	111
	Fe	ppm	63	10	18	38	39	68	11	18	27	28	47	8	15	28	30
	Pb	ppm	2	<1	<1	1	1	2	<1	<1	1	<1	1	<1	<1	1	1
	Si	ppm	18	8	9	12	11	15	7	10	10	9	14	7	9	10	10
D664 Acid	TAN Buffer	mg KOH/g		1.84			3.01		2.06			2.54		2.03			3.08

TEST Engine			MATV D14N					MATV D24					MATV D22				
			SCPL OIL B					SCPL OIL B					SCPL OIL B				
			Miles	2275.5	2643.4	3390	3396.5	*Miles*	2452.2	2779.9	3409.1	3417	*Miles*	2406.8	2764.7	3428.8	3436.6
			Accum.	-	367.9	1114.5	1121	*Accum.*	-	327.7	956.9	964.8	*Accum.*	-	357.9	1022	1029.8
			Hours	1367.7	1514.7	2024.9	2027.9	*Hours*	1146.2	1273.5	1911.9	1916.7	*Hours*	662.8	787.2	1294.1	1299.1
			Accum.	-	147	657.2	660.2	*Accum.*	-	127.3	765.7	770.5	*Accum.*	-	124.4	631.3	636.3
			As found	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units															
D445 100c	Viscosity	cSt		8.92	8.57	8.62	8.72		8.93	8.7	8.4	8.66		9	8.69	8.31	8.6
D445 40c	Viscosity	cSt		47.08			47.95		48.29			46.98		48.41			46.83
D2270	Viscosity Index			173			162		168			165		169			164
D4739	TBN Buffer	mg KOH/g		9.45		6.76	5.69		9.12		7.16	6.05		8.97		7.12	6.16
D5185	Al	ppm	2	3	4	7	7	4	4	4	4	4	3	4	4	7	7
	Cu	ppm	536	37	109	129	133	603	74	98	98	103	544	72	96	102	107
	Fe	ppm	32	4	10	20	21	43	7	11	18	20	44	8	12	22	23
	Pb	ppm	1	<1	<1	1	1	2	<1	<1	<1	<1	2	<1	<1	1	<1
	Si	ppm	12	7	7	9	8	34	10	16	18	17	15	8	8	8	8
D664 Acid	TAN Buffer	mg KOH/g		2.88			3.05		2.5			2.77		2.91			3.1

Table 43. Ft. Bliss UOA, MATV Engine, CONTROL

CONTROL Engine			MATV D12					MATV D21N				
			Miles	N/A	2227.8	2766.7	2773.6	*Miles*	N/A	2554.9	3238.1	3245.7
			Accum.	-	-	538.9	545.8	*Accum.*	-	-	683.2	690.8
			Hours	N/A	924.3	1366.8	1371.2	*Hours*	N/A	1200.2	1702.5	1706.6
			Accum.	-	-	442.5	446.9	*Accum.*	-	-	502.3	506.4
				Initial	*1st QTR*	*2nd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
Method	Property	Units										
D445 100c	Viscosity	cSt		Unit Not On Test Until 1st QTR	11.96	11.97	12.05		Unit Not On Test Until 1st QTR	12.1	12.14	12.2
D445 40c	Viscosity	cSt			85.96		87.18			87.24		89.27
D2270	Viscosity Index				132		132			132		131
D4739	TBN Buffer	mg KOH/g			4.25		2.72			3.61		2.58
D5185	Al	ppm			2	2	2			3	4	4
	Cu	ppm			697	591	633			513	501	507
	Fe	ppm			32	42	43			52	66	69
	Pb	ppm			2	2	<1			2	2	2
	Si	ppm			18	17	17			16	17	16
D664 Acid	TAN Buffer	mg KOH/g			2.48		3.02			2.9		3.7

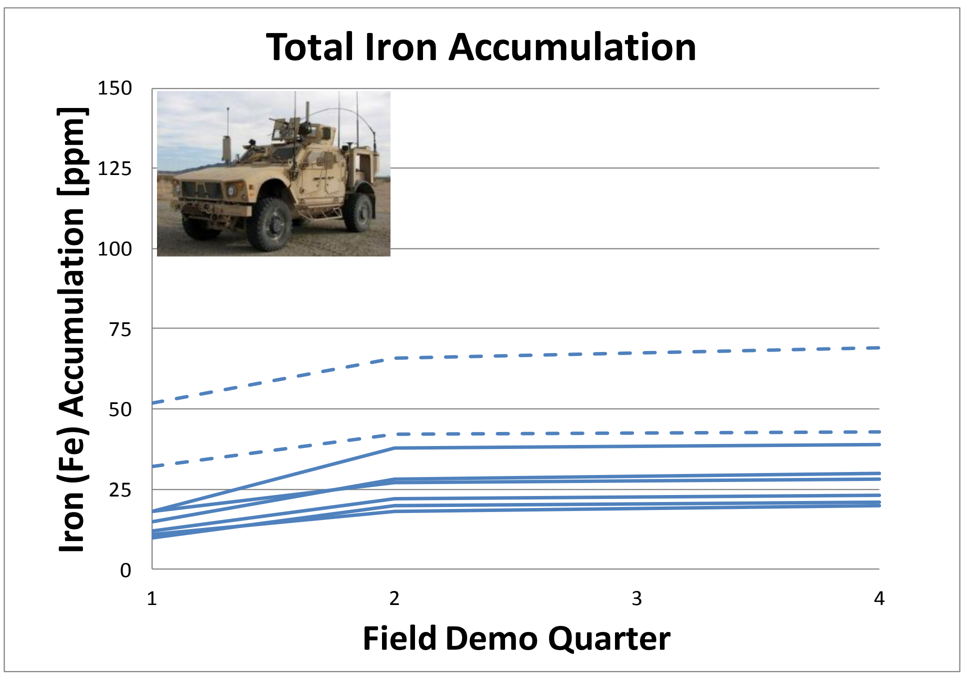

Figure 27. Ft. Bliss UOA, MATV Engine, Iron Accumulation

Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

MAXXPRO (engine)

- Little difference in used oil analysis between the TEST and CONTROL vehicles exist.
- Iron accumulation rates between TEST and CONTROL were found to be similar (see Figure 28), suggesting that the SCPL is providing comparable wear protection as the baseline MIL-PRF-2104 15W40 products.
- No appreciable differences were noted between SCPL OIL A and OIL B formulations.
- No significant source of wear metals were identified in the MAXXPRO vehicles that would suggest an incompatibility with the SCPL.
- CONTROL TBN value found to be very low across test duration
- CONTROL viscosity found to be lower than expected for MIL-PRF-2104 products

Table 44. Ft. Bliss UOA, MAXXPRO Engine, TEST

TEST Engine			MAXXPRO C107					MAXPRO HQ581				
			SCPL OIL A					SCPL OIL B				
			Miles	N/A	2113	3302	3350	Miles	7233	7645	8027	8246
			Accum.	-	-	1189	1237	Accum.	-	412	794	1013
			-	-	-	-	-	-	-	-	-	-
			-	-	-	-	-	-	-	-	-	-
			As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR
Method	Property	Units		Unit Not On Test Until 1st QTR								
D445 100c	Viscosity	cSt			8.58	7.7	7.75		8.93	8.11	7.94	7.7
D445 40c	Viscosity	cSt			47.43		39.87		48.94			40.52
D2270	Viscosity Index				160		168		165			163
D4739	TBN Buffer	mg KOH/g			8.24	7.1	6.17		8.61		7.53	6.23
D5185	Al	ppm	2		1	1	1	1	3	3	3	3
	Cu	ppm	41		7	10	12	9	2	2	4	5
	Fe	ppm	36		7	20	22	24	7	8	12	18
	Pb	ppm	7		1	2	2	2	<1	<1	2	2
	Si	ppm	16		7	7	6	4	6	4	5	5
D664 Acid	TAN Buffer	mg KOH/g			1.97		2.4		2.71			2.72

Table 45. Ft. Bliss UOA, MAXXPRO Engine, CONTROL

CONTROL Engine			MAXPRO HQ582				
			Miles	7627	7629	7629	8179
			Accum.	-	2	2	552
			-	-	-	-	-
			-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*4th QTR*
Method	**Property**	**Units**					
D445 100c	**Viscosity**	**cSt**		10.02	10.24	10.3	10.2
D445 40c	**Viscosity**	**cSt**		67.29			68.29
D2270	**Viscosity Index**			133			134
D4739	**TBN Buffer**	**mg KOH/g**		3.77			3.11
D5185	**Al**	**ppm**		<1	1	<1	<1
	Cu	**ppm**		9	8	8	9
	Fe	**ppm**		21	19	19	27
	Pb	**ppm**		2	1	2	2
	Si	**ppm**		4	4	3	4
D664 Acid	**TAN Buffer**	**mg KOH/g**		2.13			2.33

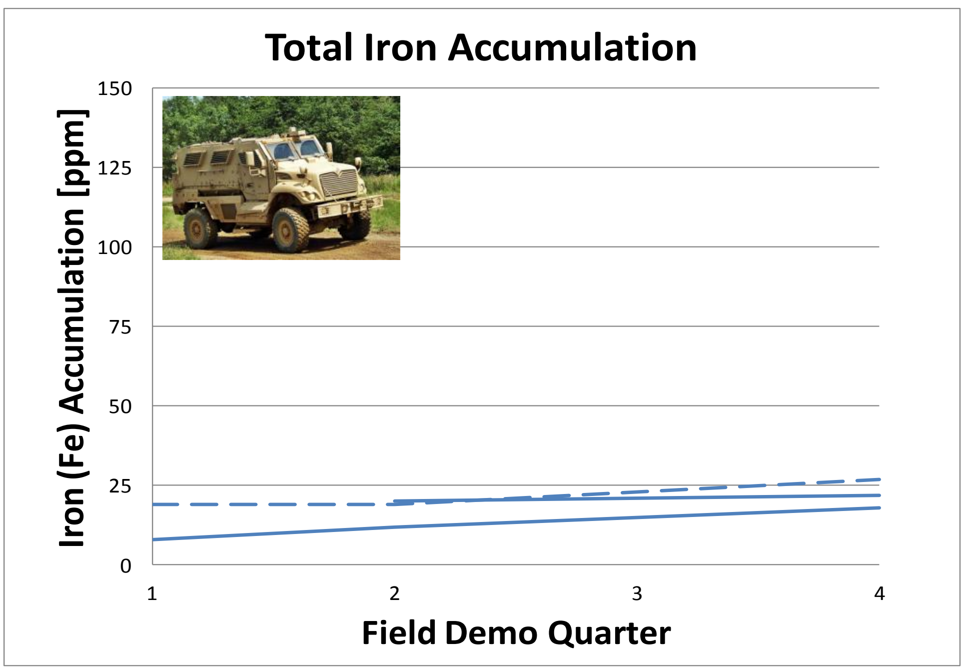

Figure 28. Ft. Bliss UOA, MAXXPRO Engine, Iron Accumulation
Note: Solid lines indicate TEST vehicles, dashed lines indicate CONTROL vehicles.

5.0 CONCLUSIONS

In conclusion, results from the field demonstration support results found during the development phases of the SCPL program [1,2,3], and demonstrate that the SCPL is a capable drop in replacement for currently utilized MIL SPEC lubricants. The SCPL successfully completed a minimum of 1-year operation in climates ranging from arctic to desert conditions as defined by AR 70-38, and provided equivalent to improved performance compared to the baseline MIL SPEC products used at each location (i.e., MIL-PRF-2104 15W40, and MIL-PRF-46167 OEA-30, where applicable). In the Ft. Benning demonstration, the SCPL remained in use for a full 2-years, demonstrating the extended drain capabilities of the SCPL. Condition of the SCPL at EOT for all locations suggest that the SCPL could continue to be used with no adverse effects. In fact, after review of the EOT oil condition, all testing locations opted to retain the SCPL in use until the vehicles next regularly scheduled oil change to reduce end of test logistics. This prevented each organization from having to coordinate vehicle availability for TFLRF to remove the SCPL and change back to the normal MIL-PRF products.

The following points outline general results and conclusions that can be made from the data acquired:

- Total miles accumulated using the SCPL in all of the field demonstrations was:
    - Ft Benning GA:
        - 38,869 miles using SCPL
        - 18,746 miles using MIL-PRF-2104 15W40
        - 57,615 miles total fleet utilization
    - Ft Wainwright AK:
        - 5,611 miles using SCPL
        - 6,346 miles using MIL-PRF-46167 OEA-30
        - 11,957 miles total fleet utilization
    - Ft Bliss TX:
        - 14,951 miles using SCPL
        - 2,621 miles using MIL-PRF-2104 15W40
        - 17,572 miles total fleet utilization

- Total, All Locations
  - 59,431 miles using SCPL
  - 27,713 miles using MIL-PRF products
  - 87,144 miles total fleet utilization

- No end-user operational differences were reported for the SCPL in comparison to baseline lubricants in any testing location.
- No maintenance issues reported to suggest that the SCPL was incompatible in any tested application.
- Iron (Fe) accumulation rates between the SCPL and the MIL-PRF-2104 15W40 support that the low viscosity (nominally SAE 0W20) SCPL is capable of providing adequate component protection when used in place of the higher viscosity 15W40 MIL-PRF-2104 lubricants when used in basic and desert temperature environments.
- Operation in arctic conditions experienced at Ft. Wainwright demonstrate that the SCPL remains capable in extreme low temperature applications (record low observed during the field demonstration exceeded -50 °F).
- Silicon (Si) ingestion is a critical issue in military vehicles, regardless of the lubricant used, and should be considered in long life lubricant applications. From data acquired, the family of M88A1/A2 and HMMWV vehicles demonstrated the most propensity to suffer from dirt ingestion/air filtration issues.
  - High silicon levels significantly impact engine wear, and is clearly documented through used oil wear metal analysis.
- Fuel and oil consumption data from the field demonstrations was ultimately not available to be collected to support laboratory data. Sufficient control over the data in the field environment was not possible without placing undue burden on the participating units, and past TFLRF experience has shown that even with specific procedures in place, this data integrity is heavily affected by human error. In this case results from laboratory testing in regards to fuel consumption improvement and oil consumption changes between the SCPL and baseline products should be considered the gold standard for comparison.

- The Caterpillar engine family shows a propensity to accumulate substantial copper levels in the used oil when new. This accumulated copper is attributed to chemical leaching of internal components, and occurs until active surfaces becomes passive over time.
  - This phenomenon was clearly identified in the HEMTT and MATV vehicles used in the SCPL demonstrations, and occurred regardless of oil type used.
  - Field results support literature information that suggests this type of copper accumulation is not identified to increase wear or oil oxidation.
- Some limited cadmium (Cd) accumulations trends show in the Bradley transmission. Sources remain unidentified, but appears in equipment using both the SCPL and MIL-PRF-2104 products.
- Copper (Cu) shows accumulation trends in the MTV transmission. Sources remain unidentified, but appears in equipment using the SCPL, MIL-PRF-2104 and MIL-PRF-46167 products.

Overall the field demonstration for all three locations was considered successful. Real world military vehicle operation using SCPL did not show any differences from currently fielded MIL-PRF-2104 and MIL-PRF-46167 products. In addition, the durability of the SCPL over the one and two year test durations showed that the SCPL is capable of extended drain intervals than the current annual oil change recommendations. These results confirms that the SCPL is a drop in replacement, and is providing improved overall performance compared to currently fielded products. All of the above support that the SCPL is meeting or exceeding its originally intended goals, and is ready for fielding in U.S. Army equipment.

6.0 REFERENCES

1. Brandt, A.C., Frame, E.A., Hansen, G.A., Warden, R.W., *"Single Common Powertrain Lubricant Development,"* Interim Report TFLRF No. 418, January 2012.

2. Brandt, A.C., Frame, E.A., Hansen, G.A., *"Single Common Powertrain Lubricant Development Part 2,"* Interim Report TFLRF No. 442, May 2014.

3. Brandt, A.C., Frame, E.A., *"Single Common Powertrain Lubricant Development Part 3,"* Draft Interim Report TFLRF No. 462, February 2015.

APPENDIX A.
Ft. Benning Field Demo Raw Data

Table A-1. Ft. Benning, Vehicle Utilization, M88A1/A2

M88 Recovery

	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		6th QTR		7th QTR		8th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST M88A1	REC8	294	71	343	79	448	2	460	4	460	4							Recordings
TEST M88A2	GMD7	531	183	546	199	615	213	627	215	629	216	637	221	639	222			Recordings
CONTROL M88A1	REC9	719	-	723	-	736	-	740	-	752	-							Recordings
CONTROL M88A2	GMD8	320	69	455	74	455	74	-	76	495	85	509	91	530	95			Recordings
TEST M88A1	REC8			49	8	105	-	13	2	0	1							Accumulation by Quarter
TEST M88A2	GMD7			15	16	69	14	12	2	3	1	8	4	2	2			Accumulation by Quarter
CONTROL M88A1	REC9			4	-	14	-	4	-	12	-							Accumulation by Quarter
CONTROL M88A2	GMD8			135	5	0	0	-	2	40	10	14	6	21	3			Accumulation by Quarter
TEST M88A1	REC8			49	8	154	10	166	14	166	18							Total Accumulation
TEST M88A2	GMD7			15	16	84	30	96	32	98	33	106	38	108	39			Total Accumulation
CONTROL M88A1	REC9			4	-	17	-	21	-	33	-							Total Accumulation
CONTROL M88A2	GMD8			135	5	135	5	-	7	175	16	189	22	210	26			Total Accumulation

Table A-2. Ft. Benning, Vehicle Utilization, Bradley

BRADLEY

	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	6th QTR Mileage	6th QTR Hours	7th QTR Mileage	7th QTR Hours	8th QTR Mileage	8th QTR Hours	
TEST	LT313	803		804		805												Recordings
TEST	LT314	723		731		739		747		964		982						
TEST	LT315	612		613		617		700		714		820		828		919		
TEST	LT316	847		848		1034		1391		1407		1726						
CONTROL	LT317	404		416		504		892		904		914		921		1072		
CONTROL	LT318	1037		1055		1108		-		1340		1411		N/A		1455		

	Bumper No.	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	6th QTR Mileage	6th QTR Hours	7th QTR Mileage	7th QTR Hours	8th QTR Mileage	8th QTR Hours	
TEST	LT313	1		1												Accumulation by Quarter
TEST	LT314	8		8		8		217		18						
TEST	LT315	1		4		83		14		106		8		91		
TEST	LT316	1		186		357		16		319						
CONTROL	LT317	12		88		388		12		10		7		151		
CONTROL	LT318	18		53		-		232		71		-		44		

	Bumper No.	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	6th QTR Mileage	6th QTR Hours	7th QTR Mileage	7th QTR Hours	8th QTR Mileage	8th QTR Hours	
TEST	LT313	1		2												Total Accumulation
TEST	LT314	8		16		24		241		259						
TEST	LT315	1		5		88		102		208		216		307		
TEST	LT316	1		187		544		560		879						
CONTROL	LT317	12		100		488		500		510		517		668		
CONTROL	LT318	18		71		-		303		374		-		418		

Note: Bradley mileage accumulation listed in kilometers (km), No hr meter readings

Table A-3. Ft. Benning, Vehicle Utilization, HMMWV

HMMWV

	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		6th QTR		7th QTR		8th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	LW024	8073		8407		8843		9081		9691		10587		-		12128		Recordings
TEST	LW026	7482		8015		8669		8874		8888		9957		10536		10625		
TEST	LW027	7480		7541		7782		8307		8798		9877		10481		11621		
TEST	LW028	49298		49476		50007		50442		51164		51935		52434		53287		
CONTROL	LW394	29038		29566		30681		31454		32079		32895		33195		33574		
CONTROL	LW395	5339		5477		5606		5983		6506		7295		7753		8089		
TEST	LW024			334		436		238		610		896		-		1540		Accumulation by Quarter
TEST	LW026			533		654		205		14		1069		579		90		
TEST	LW027			61		241		525		491		1079		604		1140		
TEST	LW028			178		531		435		721		771		500		853		
CONTROL	LW394			528		1115		773		625		816		300		379		
CONTROL	LW395			138		129		377		523		789		458		336		
TEST	LW024			334		770		1008		1618		2514		-		4055		Total Accumulation
TEST	LW026			533		1187		1392		1406		2475		3054		3143		
TEST	LW027			61		302		827		1318		2397		3001		4141		
TEST	LW028			178		709		1144		1866		2637		3136		3989		
CONTROL	LW394			528		1643		2416		3041		3857		4157		4536		
CONTROL	LW395			138		267		644		1167		1956		2414		2750		

****Note: No hr meter readings***

Table A-4. Ft. Benning, Vehicle Utilization, HEMTT

HEMTT

Bumper No.		Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		6th QTR		7th QTR		8th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	HW334	1752	172	1827	217	1834	219	1910	272	2433	276	2878	319	2960	333	2976	338	Recordings
TEST	HW336	794	100	1042	133	1174	150	1174	152	1333	169	1523	210	1625	222	1751	240	
TEST	HW337	246	33	459	58	545	73	1076	-	1981	185	3154	277	3485	301	4795	400	
TEST	HW338	4086	297	4953	361	5361	391	6112	449	6760	494	7795	585	8326	632	9614	721	
CONTROL	HW360	207	25	332	61	783	107	783	110	816	121	820	134	1208	177	1293	198	
CONTROL	HW361	1607	159	1931	189	2019	120	2154	209	2440	234	3257	316	3607	342	4796	441	

TEST	HW334	75	45	8	2	76	53	523	4	445	43	82	14	16	5	Accumulation by Quarter
TEST	HW336	248	33	132	16	0	2	159	18	190	40	102	12	126	18	
TEST	HW337	213	25	86	15	531	-	905	112	1173	93	331	24	1310	99	
TEST	HW338	867	64	409	29	751	58	648	45	1036	91	531	48	1288	89	
CONTROL	HW360	125	36	450	46	0	3	33	11	4	13	388	43	85	20	
CONTROL	HW361	324	30	88	-69	135	89	286	25	818	82	350	27	1189	98	

TEST	HW334	75	45	82	47	158	100	681	104	1126	147	1208	161	1224	166	Total Accumulation
TEST	HW336	248	33	380	50	380	52	539	69	729	110	831	122	957	140	
TEST	HW337	213	25	299	40	830	-	1735	152	2908	244	3239	268	4549	367	
TEST	HW338	867	64	1275	94	2026	152	2674	197	3709	288	4240	335	5528	424	
CONTROL	HW360	125	36	576	82	576	85	609	96	613	109	1001	152	1086	173	
CONTROL	HW361	324	30	412	-39	547	50	833	75	1650	157	2000	183	3189	282	

Table A-5. Ft. Benning, Vehicle Utilization, HET

HET

Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		6th QTR		7th QTR		8th QTR		
	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST HW127	17810	-	-	-	593	81	693	101	791	110	912	127	922	129	922	131	**Recordings**
TEST HW127			-	-	593	81	100	20	98	9	121	17	10	2	1	2	**Accumulation by Quarter**
TEST HW127			-	-	593	81	693	101	791	110	912	127	922	129	922	131	**Total Accumulation**

Table A-6. Ft. Benning, Vehicle Utilization, MTV

MTV

Bumper No.		Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	6th QTR Mileage	6th QTR Hours	7th QTR Mileage	7th QTR Hours	8th QTR Mileage	8th QTR Hours	
TEST	HW289	12789		13787		13787		13930		14086		14185		14188		14555		Recordings
TEST	HW290	10887		11310		11593		11851		12439		12895		12915		13505		
TEST	HW291	12785		12855		13092		13131		13187		13683		13738		14179		
TEST	HW301	12159		-		12253		12296		12455		12492		12637		12819		
CONTROL	HW302	12725		13487		13578		13578		13579		13626		13645		13646		
CONTROL	HW303	5421		5545		5615		5615		5647		5806		5837		7448		
TEST	HW289			998		0		143		156		99		3		367		Accumulation by Quarter
TEST	HW290			423		283		258		588		456		20		590		
TEST	HW291			70		237		39		56		496		55		441		
TEST	HW301			-		94		43		159		37		145		182		
CONTROL	HW302			762		91		0		1		47		19		1		
CONTROL	HW303			124		70		0		32		159		31		1611		
TEST	HW289			998		998		1141		1297		1396		1399		1766		Total Accumulation
TEST	HW290			423		706		964		1552		2008		2028		2618		
TEST	HW291			70		307		346		402		898		953		1394		
TEST	HW301			-		94		137		296		333		478		660		
CONTROL	HW302			762		853		853		854		901		920		921		
CONTROL	HW303			124		194		194		226		385		416		2027		

Note: No hr meter readings

Table A-7. Ft. Benning, Vehicle Utilization, Stryker

STRYKER

	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		6th QTR		7th QTR		8th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	**B52**	11674	1462	11782	1487	11795	1494	11810	1499	12001	1520	12248	1555	12521	1580	12537	1583	**Recordings**
TEST	**B53**	5955	1431	6086	1470	6135	1478	6164	1491	6288	1524	6624	1579	6717	1593	6816	1614	
TEST	**B54**	3013	584	3086	629	3237	655	3356	690	3478	725	3624	776	3701	789	3701	793	
TEST	**B55**	27731	2571	27732	2572	27777	2582	27781	2583	27788	2585	28013	2650	28039	2654	28072	2674	
CONTROL	**B57**	30027	4770	30089	4798	30274	4818	30278	4820	30424	4839	30707	4875	-	-	30810	4884	
CONTROL	**B56**	30172	5702	30214	5706	30847	5783	31674	5882	32171	5944	32692	6026	32693	6030	32709	6034	
TEST	**B52**			108	25	13	7	15	5	191	21	248	35	273	25	16	3	**Accumulation by Quarter**
TEST	**B53**			131	39	49	8	30	13	124	33	336	55	93	14	99	22	
TEST	**B54**			73	45	151	26	119	35	122	35	145	51	78	13	0	4	
TEST	**B55**			1	1	45	9	4	2	8	2	225	66	26	4	33	20	
CONTROL	**B57**			62	28	185	20	3	1	146	19	283	36	-	-	103	9	
CONTROL	**B56**			42	4	633	77	827	100	497	62	521	83	1	4	17	4	
TEST	**B52**			108	25	121	32	136	37	327	58	574	93	847	118	863	121	**Total Accumulation**
TEST	**B53**			131	39	180	47	209	60	333	93	669	148	762	162	861	183	
TEST	**B54**			73	45	224	71	343	106	465	141	611	192	688	205	688	209	
TEST	**B55**			1	1	46	11	50	12	57	14	282	79	308	83	341	103	
CONTROL	**B57**			62	28	247	48	251	50	397	69	680	105	-	-	783	114	
CONTROL	**B56**			42	4	675	81	1502	180	1999	242	2520	324	2521	328	2537	332	

Table A-8. Ft. Benning, UOA, M88A1/A2

Engine

M88A2 GMD7

Method	Property	Fresh Oil From:C97320	As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			Miles	531	545.5	552.8	614.9	626.8	629.4	637.1	638.9	-
			Accum.	-	14.5	21.8	83.9	95.8	98.4	106.1	107.9	-
			Hours	183	198.8	201.3	212.87	215.06	216.24	220.56	222.23	-
			Accum.	-	15.8	18.3	29.87	32.06	33.24	37.56	39.23	-
				84.0%	% initial changeover (calculated from vis)							
D445 100c	Viscosity	8.47	13.46	9.27	9.03	8.95	9.42	8.78	8.66	8.47	8.44	No Sample Available
D445 40c	Viscosity											
D2270	Viscosity Index											
D4739	Buffer	9.49		9.35	9.05	-	8.06	9.09	8.56	8.35	8.78	
D5185	Al	2	5	2	6	6	9	4	4	4	5	
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	B	14	7	14	13	13	12	15	16	17	19	
	Ca	902	2559	1321	1221	1218	1263	953	1020	1015	1024	
	Cr	<1	4	1	6	6	10	3	3	4	4	
	Cu	<1	5	1	4	5	10	3	4	5	5	
	Fe	1	20	6	34	31	46	17	18	25	25	
	Pb	<1	2	<1	2	2	3	<1	<1	<1	1	
	Mg	1259	261	1035	1057	1107	1131	1267	1252	1282	1321	
	Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Mo	64	5	52	54	55	58	62	63	64	67	
	Ni	<1	1	<1	2	2	2	<1	1	1	1	
	P	1079	1169	1110	1078	1087	1107	1020	986	1157	1193	
	Si	5	61	19	46	53	75	27	29	34	36	
	Ag	<1	<1	<1	<1	<1	1	<1	<1	1	2	
	Na	<5	12	7	9	10	10	6	7	7	7	
	Sn	<1	2	<1	2	1	4	<1	<1	<1	<1	
	Zn	1265	1374	1305	1324	1381	1332	1249	1272	1276	1311	
	K	<5	7	5	<5	<5	<5	<5	<5	<5	<5	
	Sr	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Cd	<1	4	<1	2	2	4	2	2	3	4	
D664 Acid	Inflect											
	Buffer	1.65		1.92	1.65	-	1.93	1.76	1.78	1.86	1.4	
IR FTNG	Oxidation											
	Nitration											
D6304	Water Content											
D3524	Fuel Dilution											

M88A1 REC8

Method	Property	As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	294	342.6	447	447.5	460	460	-	-	-
		Accum.	-	48.6	153	153.5	166	166	-	-	-
		Hours	70.5	78.8	1.75	1.76	3.71	4.49	-	-	-
		Accum.	-	8.3	-	1.76	3.71	4.49	-	-	-
			81.5%	% initial changeover (calculated from vis)							
D445 100c	Viscosity	13.87	9.47	9.38	8.73	8.6	8.78	8.72	No Longer On Test		
D445 40c	Viscosity										
D2270	Viscosity Index										
D4739	Buffer		9.33	9.13	-	9.27	9.07	8.56			
D5185	Al	4	2	5	7	7	7	8			
	Sb	<1	<1	<1	<1	<1	<1	<1			
	Ba	1	<1	<1	<1	<1	<1	<1			
	B	7	14	12	15	14	15	16			
	Ca	2723	1355	1418	1050	1054	993	1054			
	Cr	1	<1	2	1	1	1	1			
	Cu	13	3	8	5	5	6	7			
	Fe	15	5	18	15	14	17	18			
	Pb	6	1	4	2	2	2	2			
	Mg	13	949	942	1254	1258	1239	1222			
	Mn	<1	<1	<1	<1	<1	<1	<1			
	Mo	2	49	48	61	62	60	61			
	Ni	<1	<1	<1	<1	<1	<1	<1			
	P	1072	1098	1064	1091	1094	1016	971			
	Si	119	34	128	60	60	70	71			
	Ag	<1	<1	<1	<1	<1	<1	<1			
	Na	29	11	14	10	10	9	11			
	Sn	1	<1	<1	<1	<1	<1	<1			
	Zn	1829	1434	1456	1426	1338	1285	1304			
	K	6	5	<5	<5	<5	<5	<5			
	Sr	<1	<1	<1	<1	<1	<1	2			
	V	<1	<1	<1	<1	<1	<1	<1			
	Ti	<1	<1	<1	<1	<1	<1	<1			
	Cd	4	1	3	2	3	4	5			
D664 Acid	Inflect										
	Buffer		2	1.9	-	1.79	1.69	1.62			
IR FTNG	Oxidation										
	Nitration										
D6304	Water Content										
D3524	Fuel Dilution										

Table A-9. Ft. Benning, UOA, M88A1/A2 (CONT)

Control Engine

M88A2 GMD8

Method	Parameter	As found	Initial	1st QTR		2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles		320	455.1		455.4	-	495.2	509.4	530.2	-
	Accum.		-	135.1		135.4	-	175.2	189.4	210.2	-
	Hours		69	74.08		74.08	75.74	85.29	91.04	94.5	-
	Accum.		-	5.08		5.08	6.74	16.29	22.04	25.5	-
D445 100c	Viscosity		Unavailable, Control switch due to equipment ownership	12.26		12.06	12.28	12.39	12.21	12.57	No Sample Available
D445 40c	Viscosity										
D2270	Viscosity Index										
D4739	Buffer			7.27		5.66	6.86	6.17	5.48	5.53	
D5185	Al			14		13	14	11	16	15	
	Sb			<1		<1	<1	<1	<1	<1	
	Ba			<1		<1	<1	<1	<1	<1	
	B			7		8	7	7	8	9	
	Ca			2391		2388	2314	2440	2409	2526	
	Cr			8		7	7	6	8	8	
	Cu			12		12	13	13	14	15	
	Fe			70		59	66	51	67	72	
	Pb			4		4	3	3	3	4	
	Mg			383		384	381	380	372	348	
	Mn			<1		<1	<1	<1	<1	<1	
	Mo			13		14	13	14	13	12	
	Ni			3		2	2	2	2	2	
	P			1170		1174	1107	1266	1255	1287	
	Si			25		24	26	22	27	26	
	Ag			4		4	5	6	6	6	
	Na			9		9	8	8	9	9	
	Sn			4		4	2	2	3	4	
	Zn			1457		1392	1392	1419	1400	1438	
	K			<5		<5	<5	<5	<5	<5	
	Sr			<1		<1	1	<1	<1	<1	
	V			<1		<1	<1	<1	<1	<1	
	Ti			<1		<1	<1	<1	<1	<1	
	Cd			10		11	14	16	16	17	
D664 Acid	Inflect										
	Buffer			2.53		2.25	2.23	2.72	2.47	2.83	
IR FTNG	Oxidation										
	Nitration										
D6304	Water Content										
D3524	Fuel Dilution										

M88A1 REC9

Method	Parameter	As found	Initial	1st QTR		2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
	Miles		719	722.5		736.2	740	752	-	-	-
	Accum.		-	3.5		17.2	21	33	-	-	-
	Hours		100	1001		100	100	-	-	-	-
	Accum.		-	-		-	-	-	-	-	-
D445 100c	Viscosity		13.23	13.02		13	13.06	14.37	No Longer On Test		
D445 40c	Viscosity										
D2270	Viscosity Index										
D4739	Buffer		5.97	6.52		6.6	6.07	7.33			
D5185	Al		12	14		15	13	5			
	Sb		<1	<1		<1	<1	<1			
	Ba		1	<1		<1	<1	<1			
	B		2	1		2	<1	12			
	Ca		3045	2925		2904	2856	1174			
	Cr		6	7		8	7	<1			
	Cu		24	24		25	25	108			
	Fe		69	96		98	90	5			
	Pb		7	8		8	8	7			
	Mg		80	80		80	79	1068			
	Mn		1	1		1	1	<1			
	Mo		3	3		3	2	54			
	Ni		2	3		3	3	<1			
	P		1157	1131		1135	1080	1140			
	Si		80	83		84	82	9			
	Ag		<1	<1		<1	<1	<1			
	Na		10	11		11	11	<5			
	Sn		4	5		6	4	<1			
	Zn		1366	1398		1333	1341	1243			
	K		6	<5		6	<5	<5			
	Sr		1	<1		<1	1	<1			
	V		<1	<1		<1	<1	<1			
	Ti		<1	<1		<1	<1	<1			
	Cd		21	24		28	29	11			
D664 Acid	Inflect										
	Buffer		2.47	2.63		2.29	2.2	1.82			
IR FTNG	Oxidation										
	Nitration										
D6304	Water Content										
D3524	Fuel Dilution										

Table A-10. Ft. Benning, UOA,Bradley

Engine

			BRADLEY LT313									
			Kilometer	803	804	804	805	-	-	-	-	-
			Accum.	-	1	1	2	-	-	-	-	-
			Hours	-	-	-	-	-	-	-	-	-
			Accum.	-	-	-	-	-	-	-	-	-
		Fresh Oil	As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		From:C97320		79.2%	% initial changeover (calculated from vis)							
D445 100c	Viscosity	8.47	13.85	9.59	9.43	8.78	8.84	8.66				
D445 40c	Viscosity											
D2270	Viscosity Index											
D4739	Buffer	9.49		9.08	9.08	-	9.58	8.43				
D5185	Al	2	2	2	2	2	2	1				
	Sb	<1	<1	<1	<1	<1	<1	<1				
	Ba	<1	<1	<1	<1	<1	<1	<1				
	B	14	14	15	14	16	15	14				
	Ca	902	2060	1210	1185	1061	1015	1007				
	Cr	<1	2	<1	<1	<1	<1	2				
	Cu	<1	20	5	6	2	3	10				
	Fe	1	18	5	6	3	3	8				
	Pb	<1	7	2	3	1	1	2				
	Mg	1259	397	1030	1013	1249	1242	1189				
	Mn	<1	4	1	1	<1	<1	<1				
	Mo	64	13	52	49	61	61	57				
	Ni	<1	<1	<1	<1	<1	<1	<1				
	P	1079	1147	1118	1077	1090	1079	1006	No Longer On Test			
	Si	5	10	6	6	6	6	5				
	Ag	<1	<1	<1	<1	<1	<1	<1				
	Na	<5	12	7	6	6	5	6				
	Sn	<1	<1	<1	<1	<1	<1	<1				
	Zn	1265	1342	1314	1316	1376	1280	1232				
	K	<5	7	<5	<5	<5	<5	<5				
	Sr	<1	<1	<1	<1	<1	<1	<1				
	V	<1	<1	<1	<1	<1	<1	<1				
	Ti	<1	<1	<1	<1	<1	<1	<1				
	Cd	<1	1	<1	<1	<1	<1	<1				
D664 Acid	Inflect											
	Buffer	1.65		1.95	1.87	-	1.8	1.67				
IR FTNG	Oxidation											
	Nitration											
D6304	Water Content											
D3524	Fuel Dilution											

		BRADLEY LT314									
		Kilometer	723	731	739	739	747	964	982	-	-
		Accum.	-	8	16	16	24	241	259	-	-
		Hours	-	-	-	-	-	-	-	-	-
		Accum.	-	-	-	-	-	-	-	-	-
		As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			83.2%	% initial changeover (calculated from vis)							
D445 100c	Viscosity	13.11	9.25	9.29	8.68	8.72	9.41	8.77	8.25		
D445 40c	Viscosity										
D2270	Viscosity Index										
D4739	Buffer		8.32	8.38	-	9.21	8.94				
D5185	Al	3	2	2	2	2	1	2	2		
	Sb	<1	<1	<1	<1	<1	<1	<1	<1		
	Ba	<1	<1	<1	<1	<1	<1	<1	<1		
	B	5	13	12	15	14	10	14	14		
	Ca	2247	1192	1265	1066	1050	1344	1082	1032		
	Cr	3	<1	1	<1	1	2	3	6		
	Cu	62	14	17	8	8	6	13	15		
	Fe	29	7	10	5	5	6	12	20		
	Pb	7	1	2	2	1	3	2	2		
	Mg	78	983	932	1197	1206	918	1158	1178		
	Mn	1	<1	<1	<1	<1	<1	<1	<1		
	Mo	4	49	48	60	59	44	56	58		
	Ni	<1	<1	<1	<1	<1	<1	<1	<1		
	P	973	1077	1034	1068	1073	992	982	1106	No Longer On Test	
	Si	11	6	8	6	5	6	5	6		
	Ag	<1	<1	<1	<1	<1	<1	<1	<1		
	Na	8	6	6	6	5	5	6	5		
	Sn	3	<1	<1	<1	<1	<1	<1	<1		
	Zn	1196	1275	1281	1355	1277	1213	1242	1227		
	K	<5	<5	<5	<5	<5	<5	<5	<5		
	Sr	<1	<1	<1	<1	<1	<1	<1	<1		
	V	<1	<1	<1	<1	<1	<1	<1	<1		
	Ti	<1	<1	<1	<1	<1	<1	<1	<1		
	Cd	2	<1	<1	<1	<1	<1	<1	<1		
D664 Acid	Inflect										
	Buffer		1.94	2.14	-	1.71	1.67				
IR FTNG	Oxidation										
	Nitration										
D6304	Water Content										
D3524	Fuel Dilution										

Table A-11. Ft. Benning, UOA, Bradley (CONT)

				BRADLEY LT315										BRADLEY LT316									
				Kilometer	612	613	617	617	700	714	720	828	919	Kilometer	847	848	1034	1391	-	1407	1726	-	-
				Accum.	-	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	Accum.	-	#REF!	#REF!	#REF!	-	#REF!	#REF!	-	-
				Hours	-	-	-	-	-	-	-	-	-	Hours	-	-	-	-	-	-	-	-	-
				Accum.	-	-	-	-	-	-	-	-	-	Accum.	-	-	-	-	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*Special*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*Special*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		74.6%	*% initial changeover (calculated from vis)*									78.5%	*% initial changeover (calculated from vis)*							
Engine	D445 100c	Viscosity	8.47	13.62	9.78	9.56	9.53	9.42	9.58	0	0	0	0	13.45	9.54	9.38	9.68	9.53	Unable to access unit during visit	0	0	**No Longer On Test**	
	D445 40c	Viscosity			0								0		0						0		
	D2270	Viscosity Index			0								0		0						0		
	D4739	Buffer	9.49		9.06	9.37	-	9.17	8.32	0	0	0	0		8.95	9.03	-	8.84		0	0		
	D5185	Al	2	1	1	2	1	2	2	0	0	0	0	2	1	2	2	2		0	0		
		Sb	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		Ba	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		B	14	2	11	11	12	10	9	0	0	0	0	3	12	12	11	10		0	0		
		Ca	902	2781	1466	1447	1451	1420	1371	0	0	0	0	2819	1412	1375	1475	1500		0	0		
		Cr	<1	1	<1	<1	<1	<1	4	0	0	0	0	2	<1	<1	2	2		0	0		
		Cu	<1	10	3	3	4	4	8	0	0	0	0	12	3	3	5	5		0	0		
		Fe	1	10	4	4	4	4	15	0	0	0	0	16	5	5	9	10		0	0		
		Pb	<1	3	<1	1	1	1	5	0	0	0	0	6	<1	3	3	3		0	0		
		Mg	1259	35	884	902	930	938	909	0	0	0	0	18	924	945	928	930		0	0		
		Mn	<1	1	<1	<1	<1	<1	2	0	0	0	0	3	<1	<1	1	1		0	0		
		Mo	64	2	44	46	47	46	42	0	0	0	0	<1	47	48	44	45		0	0		
		Ni	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		P	1079	1102	1105	1070	1066	1068	992	0	0	0	0	1082	1099	1068	1087	1083		0	0		
		Si	5	8	6	6	5	5	7	0	0	0	0	9	6	5	6	7		0	0		
		Ag	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		Na	<5	8	6	5	6	6	8	0	0	0	0	15	8	7	8	8		0	0		
		Sn	<1	1	<1	<1	<1	<1	<1	0	0	0	0	2	<1	<1	<1	<1		0	0		
		Zn	1265	1289	1298	1301	1351	1265	1228	0	0	0	0	1267	1288	1298	1377	1283		0	0		
		K	<5	6	<5	<5	<5	<5	<5	0	0	0	0	6	5	<5	<5	<5		0	0		
		Sr	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		V	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		Ti	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
		Cd	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	<1	<1	<1	<1	<1		0	0		
	D664 Acid	Inflect													N/A								
		Buffer	1.65		1.97	1.89	-	1.85	1.89	0	0	0	0		1.93	1.87	-	1.89		0	0		
	IR FTNG	Oxidation			*								0		*						0		
		Nitration			*								0		*						0		
	D6304	Water Content			0								0		0						0		
	D3524	Fuel Dilution			*								0		*						0		

Table A-12. Ft. Benning, UOA, Bradley (CONT)

				BRADLEY LT315										BRADLEY LT316									
				Kilometer	612	613	617	617	700	714	720	828	919	Kilometer	847	848	1034	1391	-	1407	1726	-	-
				Accum.	-	1	5	5	88	102	108	216	307	Accum.	-	1	187	544	-	560	879	-	-
				Hours	-	-	-	-	-	-	-	-	-	Hours	-	-	-	-	-	-	-	-	-
				Accum.	-	-	-	-	-	-	-	-	-	Accum.	-	-	-	-	-	-	-	-	-
			Fresh Oil From:C97320	As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR	As found	Initial	1st QTR	Special	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
					88.9%	% initial changeover (calculated from vis)									84.6%	% initial changeover (calculated from vis)							
Transmission	D445 100c	Viscosty	8.47	12.88	8.96	8.99	8.97	8.98	9.02	8.85	8.62	8.72	8.58	12.89	9.15	9.05	9.02	8.95	Unable to access unit during visit	8.71	8.33	No Longer On Test	
	D445 40c	Viscosity			49.62							48.91			50.4						48.05		
	D2270	Viscosity Index			163							158			165						149		
	D4739	Buffer	9.49		9.26	9.4	-	9.44	8.7	8.68	8.83	9.13			9.47	9.37	-	9.27		8.4	8.4		
	D5185	Al	2	8	2	3	3	3	6	7	7	13	6	8	2	3	5	5		13	23		
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		B	14	3	14	16	14	12	12	14	15	14	15	4	14	14	13	12		13	13		
		Ca	902	2576	1163	1189	1235	1206	1139	1229	1175	1206	998	2643	1199	1236	1261	1232		1250	1205		
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Cu	<1	240	35	45	59	63	92	107	121	163	67	182	30	40	73	76		121	148		
		Fe	1	12	3	3	3	3	6	8	6	10	6	13	3	4	7	8		13	17		
		Pb	<1	11	1	3	4	4	6	7	7	11	5	10	2	3	6	6		10	12		
		Mg	1259	26	1090	1042	1091	1093	1073	1056	1082	1109	1233	50	1055	1026	1061	1067		1025	1060		
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Mo	64	2	57	52	54	54	51	53	53	54	58	1	55	52	52	52		52	52		
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		P	1079	1114	1105	1072	1081	1086	1011	1003	1138	1171	1141	1098	1099	1072	1075	1085		998	1142		
		Si	5	20	7	8	8	8	9	9	10	12	6	58	14	19	22	22		25	29		
		Ag	<1	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1		<1	<1		
		Na	<5	5	6	5	6	5	5	5	5	6	5	6	6	5	6	6		6	6		
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Zn	1265	1255	1293	1303	1357	1274	1236	1234	1236	1275	1233	1240	1286	1300	1350	1268		1231	1231		
		K	<5	5	5	<5	<5	<5	<5	<5	<5	<5	<5	7	<5	<5	<5	<5		<5	<5		
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1		
		Cd	<1	16	2	3	4	5	8	11	14	22	11	11	2	3	6	6		16	23		
	D664 Acid	Inflect																					
		Buffer	1.65	1.71	1.87	1.96	-	1.94	1.57	1.83	1.77	1.45		1.68	1.95	1.8	-	1.8		1.89	1.73		
	IR FTNG	Oxidation			*							0.03			*						0.1		
		Nitration			*							0			*						0		
	D6304	Water Content			698							402			963						448		
	D3524	Fuel Dilution			*							*			*						0.4		

Table A-13. Ft. Benning, UOA, Bradley (CONT)

Control Engine

BRADLEY LT317

		Kilometer	404	416		504	892	904	914	921	1072
		Accum.	-	12		100	488	500	510	517	668
		Hours	-	-	-	-	-	-	-	-	-
		Accum.	-	-	-	-	-	-	-	-	-
		As found	*Initial*	*1st QTR*		*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	Viscosty		14.14	13.82		13.37	13.5	13.41	13.21	13.18	13.24
D445 40c	Viscosity		103.88								96.13
D2270	Viscosity Index		138								137
D4739	Buffer		7	7.93		7.35	7.01	6.32	6.27	6.18	5.83
D5185	Al		1	1		1	2	2	2	2	2
	Sb		<1	<1		<1	<1	<1	<1	<1	<1
	Ba		<1	<1		<1	<1	<1	<1	<1	<1
	B		3	1		1	<1	<1	2	2	2
	Ca		2381	2366		2365	2318	2417	2328	2409	2379
	Cr		<1	<1		1	4	3	4	4	5
	Cu		10	10		12	17	18	21	24	25
	Fe		7	8		10	15	13	15	16	19
	Pb		1	2		2	3	2	2	3	3
	Mg		209	217		219	219	222	218	237	228
	Mn		<1	<1		<1	<1	<1	<1	<1	<1
	Mo		1	<1		<1	<1	1	1	1	<1
	Ni		<1	<1		<1	<1	<1	<1	<1	<1
	P		1155	1130		1133	1071	1223	1195	1232	1197
	Si		6	6		6	6	6	6	7	6
	Ag		<1	<1		<1	<1	<1	<1	<1	<1
	Na		5	<5		<5	<5	<5	<5	<5	5
	Sn		<1	<1		<1	1	1	1	2	2
	Zn		1366	1399		1338	1352	1365	1327	1378	1327
	K		7	<5		<5	<5	<5	<5	<5	<5
	Sr		<1	<1		<1	1	<1	<1	<1	<1
	V		<1	<1		<1	<1	<1	<1	<1	<1
	Ti		<1	<1		<1	<1	<1	<1	<1	<1
	Cd		<1	<1		<1	<1	<1	<1	<1	<1
D664 Acid	Inflect										
	Buffer		2.03	2.01		1.93	2	2.22	2.14	2.23	2.29
IR FTNG	Oxidation		*								0.92
	Nitration		*								0
D6304	Water Content		613								408
D3524	Fuel Dilution		*								<0.3

BRADLEY LT318

		Kilometer	1037	1055		1108	-	1340	1411	-	1455
		Accum.	-	18		71	-	303	374	-	418
		Hours	-	-	-	-	-	-	-	-	-
		Accum.	-	-	-	-	-	-	-	-	-
		As found	*Initial*	*1st QTR*		*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	Viscosty		12.44	12.42		12.35	Unable to access unit during visit	12.35	12.42	No Sample Available	12.27
D445 40c	Viscosity		88.74								86.8
D2270	Viscosity Index		136								136
D4739	Buffer		5.73	7.04		6.05		5.37	5.53		4.96
D5185	Al		2	2		2		3	3		3
	Sb		<1	<1		<1		<1	<1		<1
	Ba		<1	<1		<1		<1	<1		<1
	B		3	2		2		2	3		3
	Ca		2844	2842		2859		2915	2836		2817
	Cr		4	4		6		7	8		10
	Cu		16	16		18		22	24		28
	Fe		19	19		20		23	24		30
	Pb		6	7		7		7	6		9
	Mg		23	42		43		40	69		69
	Mn		<1	<1		<1		<1	<1		<1
	Mo		1	<1		<1		<1	1		<1
	Ni		<1	<1		<1		<1	<1		<1
	P		1094	1079		1084		1152	1154		1135
	Si		6	7		7		7	7		7
	Ag		<1	<1		<1		<1	<1		<1
	Na		6	6		6		5	6		6
	Sn		2	2		4		3	3		4
	Zn		1310	1357		1295		1300	1295		1283
	K		5	<5		<5		<5	<5		<5
	Sr		<1	1		1		1	1		1
	V		<1	<1		<1		<1	<1		<1
	Ti		<1	<1		<1		<1	<1		<1
	Cd		<1	<1		<1		<1	<1		<1
D664 Acid	Inflect										
	Buffer		2.55	2.43		2.66		2.78	2.57		2.46
IR FTNG	Oxidation		*								0.99
	Nitration		*								0.09
D6304	Water Content		611								599
D3524	Fuel Dilution		*								0.4

Table A-14. Ft. Benning, UOA, HMMWV

TEST Engine

			HMMWV LW024									HMMWV LW026								
			Miles	8073	8407.4	8843	9081.3	9691.4	10587.3	-	12127.7	*Miles*	7482	8015.4	8669.4	8874	8888.2	9956.7	10535.5	10625
			Accum.	-	334.4	770	1008.3	1618.4	2514.3	-	4054.7	*Accum.*	-	533.4	1187.4	1392	1406.2	2474.7	3053.5	3143
			Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
			Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
		Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
		From:C97320		80.2%	*% initial changeover (calculated from vis)*								77.1%	*% initial changeover (calculated from vis)*						
D445 100c	Viscosity	8.47	14.58	9.68	9.8	9.94	9.95	10.1	10	Sample Not Available	9.05	14.63	9.88	9.84	10.02	10.18	10.27	8.68	9.23	9.04
D445 40c	Viscosity			55.6					60.07				57.32				60.82	49.25		50.29
D2270	Viscosity Index			160					153				159				IC	156		162
D4739	Buffer	9.49		9.06	8.82	8.27	6.83	6.83	6.48				8.77	8.32	7.63	6.05	6.5	8.12	8.31	7.82
D5185	Al	2	2	1	2	3	3	4	3		2	4	2	3	3	3	3	1	2	2
	Sb	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	3	13	12	11	11	12	12		15	3	12	12	11	10	12	15	18	16
	Ca	902	2517	1380	1392	1434	1296	1468	1344		1014	2531	1375	1340	1349	1302	1442	1005	1091	1023
	Cr	<1	<1	<1	1	2	2	2	2		<1	5	2	3	4	4	4	2	3	2
	Cu	<1	2	<1	1	2	3	3	4		2	3	<1	2	3	4	4	1	3	2
	Fe	1	17	6	19	44	48	51	55		20	72	22	33	42	56	50	22	39	34
	Pb	<1	4	<1	4	7	7	8	9		4	6	2	4	5	7	6	2	4	4
	Mg	1259	293	1012	993	1059	1091	1076	1202		1322	298	968	1019	1107	1119	1075	1301	1390	1360
	Mn	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mo	64	3	50	48	50	50	53	59		64	5	48	50	54	54	54	63	70	66
	Ni	<1	<1	<1	<1	<1	<1	<1	<1		<1	2	<1	<1	1	1	1	<1	<1	<1
	P	1079	1225	1139	1108	1124	1042	1054	1207		1159	1194	1128	1091	1098	1027	1038	1168	1211	1164
	Si	5	11	7	13	20	22	24	30		12	22	10	19	30	37	31	14	25	19
	Ag	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	<5	5	5	5	<5	6	<5		5	<5	5	<5	<5	<5	5	<5	6	5
	Sn	<1	2	<1	<1	<1	1	2	4		1	4	<1	2	2	2	2	<1	2	2
	Zn	1265	1462	1343	1373	1357	1312	1357	1347		1288	1432	1335	1350	1325	1291	1326	1258	1351	1289
	K	<5	5	<5	<5	<5	<5	<5	<5		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	1	1	1		<1	<1	<1	<1	1	2	1	<1	1	1
D664 Acid	Inflect																			
	Buffer	1.65		1.91	1.83	1.91	1.89	2.08	2.49				2.08	2.33	2.27	2.14	2.4	2.15	1.87	2.3
IR FTNG	Oxidation			*					3.62				*				2.73	*		0.98
	Nitration			*					2.23				*				0.56	*		0.28
D6304	Water Content			735					755				762				916	825		1389
D3524	Fuel Dilution			*					<0.3				*				<0.3	*		<0.3

Table A-15. Ft. Benning, UOA, HMMWV (CONT)

TEST Engine

			HMMWV LW027									HMMWV LW028								
			Miles	7480	7541.1	7782	8306.8	8797.8	9876.6	10480.5	11620	*Miles*	49298	49475.8	50007	50442.1	51163.5	51934.8	52434.3	53286.8
			Accum.	-	61.1	302	826.8	1317.8	2396.6	3000.5	4140	*Accum.*	-	177.8	709	1144.1	1865.5	2636.8	3136.3	3988.8
			Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
			Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
		Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
		From:C97320		91.1%	*% initial changeover (calculated from vis)*								84.4%	*% initial changeover (calculated from vis)*						
D445 100c	**Viscosity**	8.47	14.56	9.01	9.57	9.61	9.72	9.71	9.88	9.93	10.31	14.57	9.42	9.72	9.88	10.02	10.39	10.32	10.05	10.8
D445 40c	**Viscosity**			49.62							59.16		52.9							64.32
D2270	**Viscosity Index**			164							164		163							159
D4739	**Buffer**	9.49		9.73	9.45	8.65	7.4	7.35	6.4	6.97	6.54		9.23	8.98	8.3	7.87	6.44	6.05	6.58	6.14
D5185	**Al**	2	2	1	2	3	3	3	4	4	5	2	1	2	3	3	4	4	4	6
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	4	15	12	13	13	14	16	14	14	2	13	12	17	13	13	14	14	11
	Ca	902	2472	1118	1305	1329	1216	1284	1225	1308	1241	2520	1240	1348	1366	1341	1525	1433	1441	1449
	Cr	<1	<1	<1	2	3	3	3	5	6	6	2	<1	2	4	4	4	5	6	8
	Cu	<1	14	2	7	12	14	14	15	17	15	2	<1	<1	4	6	6	6	7	8
	Fe	1	26	4	42	79	82	84	110	125	124	36	8	23	36	43	55	67	90	144
	Pb	<1	32	4	18	37	42	53	49	53	46	3	<1	3	10	12	12	13	14	17
	Mg	1259	297	1149	993	1034	1074	1137	1257	1334	1379	240	1059	987	1033	1075	1026	1117	1202	1218
	Mn	<1	3	<1	2	3	4	3	4	4	4	<1	<1	<1	<1	<1	<1	1	1	2
	Mo	64	3	57	48	51	53	58	69	74	75	4	50	49	51	52	53	58	63	64
	Ni	<1	<1	<1	<1	<1	1	<1	2	2	3	<1	<1	<1	1	2	2	2	2	3
	P	1079	1237	1120	1102	1102	1029	1034	1195	1228	1201	1199	1120	1090	1095	1049	1059	1202	1235	1202
	Si	5	58	11	54	106	123	119	121	139	117	11	6	14	29	32	34	37	39	45
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	6	6	6	10	9	10	9	11	9	<5	5	<5	28	27	24	20	22	20
	Sn	<1	10	<1	6	9	14	18	22	22	21	2	<1	<1	2	2	4	5	6	9
	Zn	1265	1443	1318	1344	1305	1274	1317	1333	1419	1394	1420	1318	1339	1318	1319	1359	1330	1414	1388
	K	<5	9	6	5	6	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	1	2	3	3	4	4	<1	<1	<1	2	2	2	2	2	2
D664 Acid	**Inflect**																			
	Buffer	1.65		2.02	1.95	1.76	1.62	2.03	2.27	2.07	2.82		2.03	2.01	1.88	1.71	2.33	2.63	2.19	3.35
IR FTNG	**Oxidation**			*							5.87		*							4.66
	Nitration			*							3.63		*							2.7
D6304	**Water Content**			679							444		780							885
D3524	**Fuel Dilution**			*							<0.3		*							<0.3

Table A-16. Ft. Benning, UOA, HMMWV (CONT)

Control Engine

		HMMWV LW394									HMMWV LW395								
		Miles	29038	29566.4	30681	31454.3	32079.1	32894.9	33195	33573	*Miles*	5339	5477.4	5606	5982.8	6505.9	7295.2	7753.3	8089.2
		Accum.	-	528.4	1643	2416.3	3041.1	3856.9	4157	4535	*Accum.*	-	138.4	267	643.8	1166.9	1956.2	2414.3	2750.2
		Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
		Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
		As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	**Viscosity**		14.62	14.52	14.43	14.72				14.44		14.85	14.35	14.37	14.26	14.56	14.37	14.42	14.34
D445 40c	**Viscosity**		109.57			110.62										109.64			108.21
D2270	**Viscosity Index**		137			137										IC			135
D4739	**Buffer**		6.29	6.68	4.79	5.4							8.15	7.44	7.31	7.44	5.96	5.6	5.23
D5185	**Al**		2	2	3	3	1	3	4	2		1	3	2	3	1	3	4	4
	Sb		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ba		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	B		3	2	3	2	9	8	7	2		3	2	2	3	2	3	2	2
	Ca		2541	2547	2618	2606	2306	2334	2426	2356		2583	2629	2609	2526	2514	2509	2592	2590
	Cr		2	3	3	4	2	3	4	1		2	4	4	3	1	3	4	4
	Cu		4	4	5	6	2	4	4	1		2	2	3	4	2	4	4	5
	Fe		27	33	42	47	18	37	67	19		24	47	44	48	21	51	58	62
	Pb		14	15	17	18	6	7	9	3		3	5	5	6	2	4	6	6
	Mg		284	286	299	307	263	273	300	285		221	220	231	236	274	278	306	290
	Mn		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Mo		4	4	6	6	2	4	4	2		3	3	4	4	2	4	5	4
	Ni		<1	1	1	2	<1	1	1	<1		<1	<1	<1	1	<1	<1	1	1
	P		1222	1186	1202	1138	1042	1228	1266	1268		1211	1181	1188	1128	1120	1295	1309	1274
	Si		12	13	16	18	8	14	16	7		9	10	11	14	7	12	25	24
	Ag		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Na		<5	<5	<5	<5	<5	<5	<5	<5		5	<5	<5	<5	<5	<5	5	<5
	Sn		3	4	5	6	2	4	4	1		2	4	3	3	1	3	4	5
	Zn		1451	1472	1448	1468	1276	1318	1403	1361		1422	1449	1400	1401	1404	1399	1469	1414
	K		6	<5	<5	<5	<5	<5	<5	<5		7	<5	<5	<5	<5	<5	<5	<5
	Sr		<1	1	<1	1	<1	<1	<1	<1		<1	<1	1	1	<1	<1	<1	1
	V		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Cd		2	3	4	4	1	2	2	<1		<1	<1	<1	1	<1	<1	1	1
D664 Acid	**Inflect**																		
	Buffer		2.11	2.28	2.29	2.43							2.19	1.94	1.86	2.09	2.3	2.4	2.45
IR FTNG	**Oxidation**		*			1.51										*			1.53
	Nitration		*			0.93										*			0.65
D6304	**Water Content**		576			603										734			874
D3524	**Fuel Dilution**		*			<0.3										*			<0.3

Table A-17. Ft. Benning, UOA, HEMTT

				HEMTT HW334									HEMTT HW336								
				Miles	1752	1826.6	1834.3	1910.1	2433.3	2877.9	2960.3	2976.3	*Miles*	794	1042	1174.1	1174.3	1333.4	1523.1	1624.8	1750.8
				Accum.	-	74.6	82.3	158.1	681.3	1125.9	1208.3	1224.3	*Accum.*	-	248	380.1	380.3	539.4	729.1	830.8	956.8
				Hours	172	217.3	219.45	272.05	276.05	319.2	333.25	337.9	*Hours*	100	133.2	149.6	151.65	169.25	209.6	221.85	240.3
				Accum.	-	45.3	47.45	100.05	104.05	147.2	161.25	165.9	*Accum.*	-	33.2	49.6	51.65	69.25	109.6	121.85	140.3
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		77.2%	*% initial changeover (calculated from vis)*								76.6%	*% initial changeover (calculated from vis)*						
Engine	D445 100c	Viscosity	8.47	11.41	9.14	9.14	8.63	8.67	9.05	No Longer On Test, Oil Changed to MIL-PRF-2104			10.48	8.94	8.9	8.83	8.65	8.88	8.67	8.49	8.8
	D445 40c	Viscosity			52.4				50.45					50.02							48.53
	D2270	Viscosity Index			157				IC					160							162
	D4739	Buffer	9.49		8.7	8.5	8.42	7.29	7.18					8.79	8.44	8.18	6.93	7.38	6.7	7.4	6.64
	D5185	Al	2	3	2	2	2	2	2				2	1	2	2	2	2	2	2	2
		Sb	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	2	1	1	<1	<1	<1				2	<1	1	<1	1	1	1	<1	<1
		B	14	4	12	13	11	10	11				4	12	12	11	11	11	9	11	11
		Ca	902	2819	1498	1542	1511	1404	1515				2536	1371	1488	1453	1354	1457	1506	1417	1388
		Cr	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	106	32	38	38	41	59				59	16	27	30	31	36	42	42	44
		Fe	1	27	9	17	17	19	27				20	6	16	22	21	28	37	43	55
		Pb	<1	7	2	3	3	3	3				6	2	3	3	3	3	3	3	3
		Mg	1259	47	887	848	864	847	837				48	915	847	869	849	836	881	956	959
		Mn	<1	3	1	1	1	1	1				2	<1	<1	1	<1	1	1	1	1
		Mo	64	1	46	43	42	41	43				1	45	43	42	41	43	44	47	46
		Ni	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1119	1106	1085	1059	985	946				1068	1095	1066	1053	975	939	1120	1152	1103
		Si	5	85	29	34	34	35	39				83	26	35	37	38	41	45	42	43
		Ag	<1	1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	1
		Na	<5	7	6	6	5	5	6				10	6	7	6	6	8	7	7	6
		Sn	<1	4	<1	<1	<1	<1	<1				2	<1	<1	<1	<1	<1	<1	<1	1
		Zn	1265	1294	1291	1319	1248	1199	1230				1220	1275	1299	1234	1183	1215	1240	1260	1224
		K	<5	18	9	7	8	6	7				6	<5	<5	6	5	6	8	9	7
		Sr	<1	<1	<1	<1	<1	<1	1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1				<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Inflect																			
		Buffer	1.65		2	2.01	1.93	1.55	2.11					1.93	1.8	1.77	1.68	1.9	1.91	1.66	2.29
	IR FTNG	Oxidation			*				-0.15					*							0.29
		Nitration			*				0					*							0.19
	D6304	Water Content			996				862					787							737
	D3524	Fuel Dilution			*				2					*							<0.3

Table A-18. Ft. Benning, UOA, HEMTT (CONT)

Engine

Test	Parameter	Fresh Oil	HEMTT HW337								
			Miles	246	459.1	544.9	1075.6	1980.9	3154.1	3485.3	4795.1
			Accum.	-	213.1	298.9	829.6	1734.9	2908.1	3239.3	4549.1
			Hours	33	58.1	72.7		184.5	277.4	301.4	400.05
			Accum.	-	25.1	39.7		151.5	244.4	268.4	367.05
		Fresh Oil	As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		From:C97320		71.6%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	8.47	10.48	9.04	8.88	8.64	8.9	9.04	8.85	9.02	9.05
D445 40c	Viscosity			50.04							50.19
D2270	Viscosity Index			163							163
D4739	Buffer	9.49		9.09	8.93	8.68	7.98	6.73	5.5	5.66	4.74
D5185	Al	2	1	1	2	2	2	2	3	3	3
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	2	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	5	13	12	10	10	10	8	9	9
	Ca	902	2294	1287	1354	1314	1250	1345	1376	1352	1324
	Cr	<1	<1	<1	<1	<1	<1	<1	1	1	1
	Cu	<1	23	6	14	17	24	32	41	46	61
	Fe	1	10	4	14	22	26	31	40	59	66
	Pb	<1	3	<1	2	2	2	2	3	2	3
	Mg	1259	214	960	905	930	916	902	949	968	974
	Mn	<1	2	<1	1	1	1	2	2	2	2
	Mo	64	2	46	44	43	42	44	45	45	44
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1118	1099	1078	1068	988	954	1123	1151	1103
	Si	5	75	25	36	40	48	53	62	64	65
	Ag	<1	<1	<1	<1	<1	<1	<1	1	2	1
	Na	<5	5	6	5	5	<5	7	5	6	5
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	2
	Zn	1265	1301	1287	1318	1262	1214	1246	1260	1275	1240
	K	<5	8	7	<5	<5	9	10	12	15	16
	Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Inflect										
	Buffer	1.65		1.95	1.92	1.65	1.63	1.88	2.46	1.91	2.63
IR FTNG	Oxidation			*							1.12
	Nitration			*							0.09
D6304	Water Content			823							496
D3524	Fuel Dilution			*							0.3

Test	Parameter	HEMTT HW338								
		Miles	4086	4952.6	5361.1	6111.8	6759.5	7795.2	8325.8	9613.8
		Accum.	-	866.6	1275.1	2025.8	2673.5	3709.2	4239.8	5527.8
		Hours	297	361.4	390.7	448.8	493.65	586.55	632.05	721.15
		Accum.	-	64.4	93.7	151.8	196.65	289.55	335.05	424.15
		As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
			77.5%	% initial changeover (calculated from vis)						
D445 100c	Viscosity	10.69	8.97	8.9	8.72	9.01	8.42	8.23	8.83	8.96
D445 40c	Viscosity		50.23						48.95	
D2270	Viscosity Index		160						162	
D4739	Buffer		8.22	7.15	6.86	4.8	5.36	5.04	5.42	
D5185	Al	3	2	2	3	3	3	4	3	3
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	2	<1	<1	<1	<1	<1	<1	<1	<1
	B	4	13	11	10	9	9	8	8	9
	Ca	2698	1423	1457	1426	1398	1425	1414	1402	1324
	Cr	1	<1	<1	1	1	2	2	2	1
	Cu	192	54	81	87	109	123	382	741	61
	Fe	36	11	24	31	36	43	51	58	66
	Pb	7	2	3	3	3	3	3	3	3
	Mg	51	917	856	871	888	850	920	907	974
	Mn	3	1	1	1	2	2	2	2	2
	Mo	2	47	44	43	43	43	46	45	44
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1052	1096	1052	1032	1001	913	1079	1090	1103
	Si	83	27	33	35	40	38	41	40	65
	Ag	1	<1	<1	<1	1	1	1	1	1
	Na	6	6	6	5	6	7	6	6	5
	Sn	3	<1	<1	<1	<1	<1	<1	1	2
	Zn	1229	1284	1293	1221	1218	1195	1216	1231	1240
	K	23	9	11	14	16	18	18	21	16
	Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Inflect									
	Buffer		2.07	1.98	2.1	2.13	2.34	2.46	2.27	
IR FTNG	Oxidation		*						1.67	
	Nitration		*						0	
D6304	Water Content		892						639	
D3524	Fuel Dilution		*						1.2	

Table A-19. Ft. Benning, UOA, HEMTT (CONT)

Transmission

			HEMTT HW337								
			Miles	246	459.1	544.9	1075.6	1980.9	3154.1	3485.3	4795.1
			Accum.	-	213.1	298.9	829.6	1734.9	2908.1	3239.3	4549.1
			Hours	33	58.1	72.7	434.2	184.5	277.4	301.4	400.05
			Accum.	-	25.1	39.7	401.2	151.5	244.4	268.4	367.05
		Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
		From:C97320		75.4%	*% initial changeover (calculated from vis)*						
D445 100c	**Viscosity**	8.47	11.8	9.29	9.17	9.12	8.84	8.69	8.51	8.34	8.43
D445 40c	**Viscosity**			52.5							46.96
D2270	**Viscosity Index**			161							157
D4739	**Buffer**	9.49		8.64	8.79	8.94	8.42	8.28	8.37	8.93	8.24
D5185	**Al**	2	1	1	2	2	2	2	3	3	3
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	2	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	29	19	20	20	18	19	17	18	19
	Ca	902	1939	1222	1237	1216	1132	1139	1134	1128	1125
	Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cu	<1	7	2	3	4	4	5	7	7	8
	Fe	1	8	3	5	5	6	7	9	9	10
	Pb	<1	2	<1	1	1	1	1	<1	2	2
	Mg	1259	171	939	923	976	1025	1013	1051	1073	1104
	Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mo	64	2	45	44	46	47	50	50	50	51
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1027	1081	1052	1047	996	942	1113	1135	1119
	Si	5	5	5	5	5	4	3	4	4	4
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	5	5	5	5	<5	5	<5	<5	<5
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1127	1248	1263	1216	1208	1194	1212	1235	1214
	K	<5	8	5	<5	5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	**Inflect**										
	Buffer	1.65	1.37	1.93	2.08	1.73	1.5	1.86	1.6	1.47	1.67
IR FTNG	**Oxidation**			*							1.03
	Nitration			*							0.37
D6304	**Water Content**			740							378
D3524	**Fuel Dilution**			*							*

			HEMTT HW338								
			Miles	4086	4952.6	5361.1	6111.8	6759.5	7795.2	8325.8	9613.8
			Accum.	-	866.6	1275.1	2025.8	2673.5	3709.2	4239.8	5527.8
			Hours	297	361.4	390.7	448.8	493.65	586.55	632.05	721.15
			Accum.	-	64.4	93.7	151.8	196.65	289.55	335.05	424.15
		Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
		From:C97320		72.1%	*% initial changeover (calculated from vis)*						
D445 100c	**Viscosity**	8.47	10.26	8.97	8.75	8.65	8.45	8.42	8.29	8.1	8.32
D445 40c	**Viscosity**			50.59							46.43
D2270	**Viscosity Index**			159							156
D4739	**Buffer**	9.49		8.52	8.69	8.82	8.34	8.05	8.08	8.69	8.06
D5185	**Al**	2	4	2	3	3	3	4	4	4	5
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	2	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	31	20	20	17	17	18	17	18	19
	Ca	902	2312	1380	1454	1424	1369	1418	1434	1348	1350
	Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cu	<1	36	11	13	12	13	14	15	14	16
	Fe	1	15	6	9	8	9	10	10	11	12
	Pb	<1	4	<1	2	1	1	2	1	2	2
	Mg	1259	8	863	770	849	838	808	876	915	947
	Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mo	64	1	45	40	41	41	41	42	44	45
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	975	1061	1038	1054	988	932	1115	1121	1115
	Si	5	5	5	4	4	4	4	4	4	4
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	5	5	5	5	<5	5	5	5	5
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1034	1212	1230	1207	1181	1173	1201	1211	1208
	K	<5	7	5	<5	<5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	**Inflect**										
	Buffer	1.65	1.19	1.7	1.63	1.76	1.43	1.75	1.7	1.37	1.6
IR FTNG	**Oxidation**			*							0.14
	Nitration			*							0
D6304	**Water Content**			626							335
D3524	**Fuel Dilution**			*							*

Table A-20. Ft. Benning, UOA, HEMTT (CONT)

Control Engine

		HEMTT HW360								
		Miles	207	332.3	782.6	782.9	816	820	1207.9	1293.1
		Accum.	-	125.3	575.6	575.9	609	613	1000.9	1086.1
		Hours	25	60.95	107.25	110.1	121.05	134.45	177.45	197.8
		Accum.	-	35.95	82.25	85.1	96.05	109.45	152.45	172.8
		As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	Viscosity		11.52	11.43	11.66	11.33	11.48	11.11	11.03	10.95
D445 40c	Viscosity		79.41							73.05
D2270	Viscosity Index		137							139
D4739	Buffer		8.02	8.22	6.9	7.54	6.97	6.62	6.26	6.03
D5185	Al		2	2	2	2	2	4	4	4
	Sb		<1	<1	<1	<1	<1	<1	<1	<1
	Ba		2	2	2	2	2	2	2	2
	B		5	4	4	3	4	3	4	5
	Ca		2749	2686	2722	2642	2762	2769	2532	2577
	Cr		<1	<1	<1	<1	<1	<1	1	1
	Cu		36	42	61	62	67	74	86	94
	Fe		11	14	19	19	24	40	55	62
	Pb		4	6	6	6	6	6	7	6
	Mg		72	71	80	80	80	80	206	205
	Mn		2	2	2	2	2	2	2	2
	Mo		2	1	1	<1	<1	1	7	8
	Ni		<1	<1	<1	<1	<1	<1	<1	<1
	P		1151	1111	1125	1059	1007	1180	1192	1179
	Si		78	80	86	84	87	91	86	89
	Ag		<1	<1	<1	<1	<1	1	1	1
	Na		8	8	8	7	8	9	9	9
	Sn		<1	2	2	2	2	2	2	3
	Zn		1299	1315	1277	1279	1275	1276	1292	1277
	K		11	8	11	9	10	16	19	19
	Sr		<1	1	1	1	2	<1	<1	<1
	V		<1	<1	<1	<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1	<1	<1	<1
	Cd		<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Inflect									
	Buffer		1.88	1.9	2.02	1.72	2.02	1.88	2.25	2.29
IR FTNG	Oxidation		*							1.3
	Nitration		*							1.77
D6304	Water Content		962							726
D3524	Fuel Dilution		*							<0.3

		HEMTT HW361								
		Miles	1607	1931.2	2018.9	2153.5	2439.5	3257.2	3607.1	4795.7
		Accum.	-	324.2	411.9	546.5	832.5	1650.2	2000.1	3188.7
		Hours	159	188.7	119.9	208.95	234.2	315.85	342.35	440.7
		Accum.	-	29.7	-	49.95	75.2	156.85	183.35	281.7
		As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	Viscosity		11.48	11.79	11.39	11.35	11.51			12.5
D445 40c	Viscosity		79.38				79.56			
D2270	Viscosity Index		136				IC			
D4739	Buffer		6.58	7.06	5.99	6.31	5.58			
D5185	Al		2	3	3	3	3	2	2	3
	Sb		<1	<1	<1	<1	<1	<1	<1	<1
	Ba		2	2	2	2	2	<1	<1	<1
	B		3	2	2	1	2	<1	<1	2
	Ca		2787	2798	2780	2714	2818	2587	2513	2584
	Cr		<1	<1	<1	<1	<1	<1	<1	<1
	Cu		97	113	118	124	144	62	69	88
	Fe		25	38	39	43	49	35	56	65
	Pb		5	6	6	6	6	2	2	3
	Mg		55	56	56	56	55	218	222	223
	Mn		3	3	3	3	3	1	2	2
	Mo		2	1	1	<1	<1	<1	<1	<1
	Ni		<1	<1	<1	<1	<1	<1	<1	<1
	P		1144	1112	1122	1046	996	1266	1277	1263
	Si		84	88	89	88	91	35	36	40
	Ag		<1	<1	<1	1	1	<1	<1	<1
	Na		8	8	8	8	10	<5	<5	5
	Sn		2	2	2	2	3	<1	<1	2
	Zn		1308	1330	1282	1278	1270	1404	1412	1407
	K		15	13	14	12	12	7	10	10
	Sr		<1	1	<1	1	<1	<1	<1	<1
	V		<1	<1	<1	<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1	<1	<1	<1
	Cd		<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Inflect									
	Buffer		2.28	2.2	2.08	2.29	2.38			
IR FTNG	Oxidation		*				0.62			
	Nitration		*				0			
D6304	Water Content		794				474			
D3524	Fuel Dilution		*				0.4			

Table A-21. Ft. Benning, UOA, HET

				HET HW127								
				Miles	17810	-	592.6	692.7	790.8	911.5	921.8	922.3
				Accum.	-	-	-					
				Hours	-	-	80.9	101.2	110.3	127	129.4	131.2
				Accum.	-	-	-					
			Fresh Oil	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***6th QTR***	***7th QTR***	***8th QTR***
			From:C97320			*% initial changeover (calculated from vis)*						
Engine	**D445 100c**	**Viscosity**	8.47	11.42	9.05	Out of service, Engine head gasket failure	9.05	9.11	8.95	8.8	8.75	8.84
	D445 40c	**Viscosity**					50.59					48.37
	D2270	**Viscosity Index**					161					164
	D4739	**Buffer**	9.49		9.05		8.65	8.35	7.63	7.23	7.95	7.55
	D5185	**Al**	2	1	1		3	2	3	2	2	2
		Sb	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1		<1	<1	<1	<1	<1	<1
		B	14	2	14		12	12	13	12	14	14
		Ca	902	2607	1262		1125	1072	1108	1108	1089	1059
		Cr	<1	4	<1		6	6	7	8	7	7
		Cu	<1	7	1		29	30	33	36	32	33
		Fe	1	137	26		60	69	81	95	85	87
		Pb	<1	3	<1		15	14	15	16	14	13
		Mg	1259	228	1081		1226	1236	1198	1229	1292	1289
		Mn	<1	1	<1		2	2	2	3	2	2
		Mo	64	2	54		63	60	60	62	66	63
		Ni	<1	<1	<1		<1	<1	<1	<1	<1	<1
		P	1079	1193	1117		1082	1028	964	1136	1185	1130
		Si	5	41	13		121	132	141	159	135	134
		Ag	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Na	<5	<5	5		22	24	26	28	25	25
		Sn	<1	10	<1		19	23	26	29	22	23
		Zn	1265	1433	1325		1326	1300	1293	1305	1333	1288
		K	<5	5	<5		5	<5	<5	<5	5	<5
		Sr	<1	<1	<1		<1	<1	<1	<1	<1	<1
		V	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1		<1	<1	<1	<1	<1	<1
	D664 Acid	**Inflect**										
		Buffer	1.65		2.06		2.08	1.88	2.1	1.91	1.68	2.14
	IR FTNG	**Oxidation**					*					0.52
		Nitration					*					0.19
	D6304	**Water Content**					608					962
	D3524	**Fuel Dilution**					*					0.4

Table A-22. Ft. Benning, UOA, HET (CONT)

				HET HW127								
				Miles	17810	-	592.6	692.7	790.8	911.5	921.8	922.3
				Accum.	-	-	-					
				Hours	-	-	80.9	101.2	110.3	127	129.4	131.2
				Accum.	-	-	-					
			Fresh Oil	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***6th QTR***	***7th QTR***	***8th QTR***
			From:C97320			*% initial changeover (calculated from vis)*						
Transmission	**D445 100c**	**Viscosity**	8.47	6.86	8.21	Out of service, Engine head gasket failure	8.13	8.28	8.18	7.9	8.05	8.13
	D445 40c	**Viscosity**			44.64							44.14
	D2270	**Viscosity Index**			161							160
	D4739	**Buffer**	9.49		8.61		8.98	8.81	8.09		8.86	8.28
	D5185	**Al**	2	18	4		4	3	3	4	3	4
		Sb	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1		<1	<1	<1	<1	<1	<1
		B	14	18	17		15	15	18	16	17	17
		Ca	902	2104	1114		1045	990	1034	1019	1043	1032
		Cr	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Cu	<1	217	33		33	36	38	40	42	41
		Fe	1	53	9		8	8	8	10	9	9
		Pb	<1	15	2		3	3	4	4	4	4
		Mg	1259	267	1112		1203	1195	1162	1200	1243	1273
		Mn	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Mo	64	15	58		60	57	58	59	61	59
		Ni	<1	<1	<1		<1	<1	<1	<1	<1	<1
		P	1079	944	1078		1055	991	937	1106	1153	1121
		Si	5	6	5		6	7	6	7	8	7
		Ag	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Na	<5	6	6		6	5	8	6	6	5
		Sn	<1	3	<1		<1	<1	<1	<1	<1	<1
		Zn	1265	1084	1264		1243	1223	1215	1222	1259	1231
		K	<5	<5	<5		<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1		<1	<1	<1	<1	<1	<1
		V	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1		<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1		<1	<1	<1	<1	<1	<1
	D664 Acid	**Inflect**										
		Buffer	1.65	1.48	1.85		1.72	1.53	1.79	1.97	1.52	1.9
	IR FTNG	**Oxidation**			*							0.7
		Nitration			*							0.09
	D6304	**Water Content**			684							761
	D3524	**Fuel Dilution**			*							*

Table A-23. Ft. Benning, UOA, MTV

				MTV HW289									MTV HW290								
Engine				*Miles*	12789	13787	13787	13930	14086	14185	14188	14555	*Miles*	10887	11310	11593	11851	12439	12895	12915	13505
				Accum.	-	998	998	1141	1297	1396	1399	1766	*Accum.*	-	423	706	964	1552	2008	2028	2618
				Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
				Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		93.5%	*% initial changeover (calculated from vis)*								92.9%	*% initial changeover (calculated from vis)*						
	D445 100c	Viscosity	8.47	12.64	8.74	8.88	8.93	8.95	9.33	9.16	9.14	9.21	12.99	8.79	8.98	8.92	9.01	8.45	8.38	8.35	8.45
	D445 40c	Viscosity			47.42							52.68		48.26							45.64
	D2270	Viscosity Index			166							158		163							164
	D4739	Buffer	9.49		9.62	9.01	8.93	7.58	7.8	7.86	8.19	7.07		9.42	8.82	8.47	6.43	8.24	7.89	8.87	7.51
	D5185	Al	2	<1	1	2	2	<1	1	<1	1	2	<1	1	2	2	1	2	1	1	2
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	4	16	14	12	13	12	12	10	10	2	14	13	10	11	15	14	14	12
		Ca	902	2432	1045	1154	1142	1104	1293	1247	1291	1266	2388	1073	1198	1210	1152	966	940	961	934
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Fe	1	7	2	3	3	4	4	5	6	9	3	1	4	6	6	4	7	8	10
		Pb	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
		Mg	1259	237	1194	1105	1141	1147	1012	1029	1044	1028	283	1174	1071	1117	1124	1271	1302	1317	1305
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	1	64	55	54	54	49	48	49	47	1	59	52	53	52	63	64	66	62
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1186	1112	1088	1091	1036	986	1169	1185	1162	1267	1120	1098	1110	1057	968	1157	1170	1146
		Si	5	3	5	4	4	4	4	4	5	5	3	5	4	4	4	4	5	5	4
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	5	<5	5	6	<5	5	5	<5	5	5	<5	5	6	<5	5	5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1383	1303	1334	1292	1276	1287	1262	1313	1273	1468	1311	1349	1318	1297	1280	1256	1300	1252
		K	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Inflect																			
		Buffer	1.65		1.97	1.92	1.9	1.66	1.98	1.99	1.63	2.25		2.1	2.08	2.09	1.94	2.04	2.18	1.83	2.56
	IR FTNG	Oxidation			*							2.8		*							2.14
		Nitration			*							0.28		*							0.37
	D6304	Water Content			676							646		629							839
	D3524	Fuel Dilution			*							<0.3		*							<0.3

Table A-24. Ft. Benning, UOA, MTV (CONT)

				MTV HW291									MTV HW301								
Engine				*Miles*	12785	12855	13092	13131	13187	13683	13738	14179	*Miles*	12159	-	12253	12296	12455	12492	12637	12819
				Accum.	-	70	307	346	402	898	953	1394	*Accum.*	-	-	94	137	296	333	478	660
				Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
				Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		86.0%	*% initial changeover (calculated from vis)*								90.1%	*% initial changeover (calculated from vis)*						
	D445 100c	Viscosity	8.47	12.54	9.04	8.98	8.87	9.04	8.88	8.6	8.6	8.79	13.32	8.95	8.89	8.81	8.92	8.74	8.46	8.38	8.65
	D445 40c	Viscosity			50.41							48.77		49.57							47.36
	D2270	Viscosity Index			162							161		163							163
	D4739	Buffer	9.49		9.01	9.15	8.75	8.61	8.02	7.49	7.73	7.04		9.37	9.53	9.62	9.36	8.53	8.7	8.75	8.04
	D5185	Al	2	<1	1	2	2	<1	1	<1	<1	2	<1	1	2	2	<1	1	<1	<1	2
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	3	14	13	12	12	13	12	11	13	3	14	14	15	13	14	13	14	15
		Ca	902	2434	1190	1190	1174	1101	1162	1117	1151	1121	2483	1107	1117	1105	1005	1096	1062	1057	1047
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	3	<1	<1	<1	1	1	1	2	2	2	<1	<1	2	<1	<1	<1	2	1
		Fe	1	7	2	4	4	4	5	6	8	10	5	2	2	3	3	4	4	6	8
		Pb	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mg	1259	253	1098	1089	1123	1099	1117	1134	1148	1156	266	1137	1155	1179	1142	1157	1189	1200	1265
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	2	55	54	54	51	55	54	55	54	1	57	57	58	54	55	57	58	59
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1192	1124	1093	1091	1012	1010	1155	1170	1152	1211	1118	1102	1088	995	1008	1156	1160	1143
		Si	5	3	5	4	4	4	4	5	5	5	2	5	4	4	4	4	5	5	5
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	5	<5	<5	<5	<5	<5	<5	<5	5	5	<5	<5	<5	<5	<5	<5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1397	1315	1341	1295	1242	1268	1257	1301	1259	1405	1306	1350	1292	1220	1261	1247	1289	1271
		K	<5	5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Inflect																			
		Buffer	1.65		1.93	1.89	1.86	1.7	1.9	2.17	1.84	2.4		2.05	1.86	1.95	1.56	1.84	1.79	1.48	2.12
	IR FTNG	Oxidation			*							1.04		*							0.71
		Nitration			*							0.19		*							0.09
	D6304	Water Content			727							540		795							461
	D3524	Fuel Dilution			*							<0.3		*							<0.3

Table A-25. Ft. Benning, UOA, MTV (CONT)

				MTV HW291									MTV HW301								
				Miles	12785	12855	13092	13131	13187	13683	13738	14179	*Miles*	12159	12296	12296	N/A	12455	12492	12637	12819
				Accum.	-	70	307	346	402	898	953	1394	*Accum.*	-	137	137	N/A	296	333	478	660
				Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
				Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		54.9%	*% initial changeover (calculated from vis)*								56.4%	*% initial changeover (calculated from vis)*						
Transmission	D445 100c	Viscosity	8.47	10.09	9.2	8.98	8.89	8.86	8.94	8.78	8.73	8.78	10.58	9.39	9.07	8.99	9.07	9.01	8.85	8.84	8.94
	D445 40c	Viscosity			54.88							51.67		57.84							53.03
	D2270	Viscosity Index			149							149		144							149
	D4739	Buffer	9.49		8.52	8.72	8.48	7.87	7.51	7.81	8.19	7.69		8.24	8.78	8.95	8.22	7.98	8.26	8.6	8.1
	D5185	Al	2	9	5	5	5	4	5	4	4	5	9	5	5	5	4	4	3	4	5
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	146	85	75	73	74	79	72	74	77	132	76	64	61	60	65	65	63	66
		Ca	902	2753	1744	1656	1654	1622	1716	1640	1634	1658	3097	1997	1747	1738	1674	1768	1709	1728	1764
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	414	194	170	174	184	200	205	223	252	348	181	138	146	157	182	201	237	294
		Fe	1	57	29	25	24	24	25	24	25	28	64	34	25	26	25	25	24	27	31
		Pb	<1	12	6	6	5	5	5	5	6	5	7	3	4	3	3	3	3	4	3
		Mg	1259	10	638	718	741	736	722	769	766	790	12	603	755	801	794	774	795	803	834
		Mn	<1	3	2	1	1	1	2	2	2	2	2	1	1	1	1	1	2	2	2
		Mo	64	87	79	74	75	72	72	76	74	76	93	79	75	76	72	72	76	75	78
		Ni	<1	2	<1	<1	<1	<1	<1	1	1	2	2	<1	<1	<1	<1	<1	<1	1	2
		P	1079	1104	1114	1062	1052	1005	992	1132	1118	1124	1181	1164	1101	1097	1033	1030	1172	1163	1181
		Si	5	10	7	7	6	6	6	6	6	6	8	6	6	6	6	5	6	6	6
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	5	6	5	5	5	5	<5	<5	5	6	5	<5	5	<5	6	<5	<5	5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1347	1325	1340	1298	1275	1264	1256	1285	1272	1467	1386	1378	1342	1327	1314	1291	1338	1326
		K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	17	9	8	8	8	8	8	8	9	19	10	8	8	9	10	11	13	15
	D664 Acid	Inflect																			
		Buffer	1.65	1.1	1.58	1.47	1.44	1.25	1.63	1.51	1.25	1.64	1.57	1.87	1.77	1.58	1.47	1.76	1.73	1.48	1.59
	IR FTNG	Oxidation			*							0.38		*							0.47
		Nitration			*							0.19		*							0.19
	D6304	Water Content			676							777		817							944
	D3524	Fuel Dilution			*							*		*							*

Table A-26. Ft. Benning, UOA, MTV (CONT)

Control Engine

			MTV HW302									MTV HW303							
		Miles	12725	13487	13578	13578	13579	13626	13645	13646	*Miles*	5421	5545	5615	5615	5647	5806	5837	7448
		Accum.	-	762	853	853	854	901	920	921	*Accum.*	-	124	194	194	226	385	416	2027
		Hours	-	-	-	-	-	-	-	-	*Hours*	-	-	-	-	-	-	-	-
		Accum.	-	-	-	-	-	-	-	-	*Accum.*	-	-	-	-	-	-	-	-
		As found	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
D445 100c	**Viscosity**		13.58	12.82	12.68	12.82	13.02	13.71	13.64	13.55		13.4	13.28	14.38	14.38	13.84	13.68	13.65	12.75
D445 40c	**Viscosity**		100.11							100.8		98.46							93.38
D2270	**Viscosity Index**		136							134		135							133
D4739	**Buffer**		8.29	8.12	7.4	7.81	7.35	8.65	8.58	8.51		7.95	8.64	8.84	8.98	8.59	8.51	8.44	6.63
D5185	**Al**		<1	<1	<1	<1	<1	<1	<1	1		<1	<1	<1	<1	<1	<1	<1	1
	Sb		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ba		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	B		2	2	3	<1	2	3	<1	<1		5	4	2	<1	1	2	<1	2
	Ca		2416	2434	2417	2336	2474	2309	2398	2460		2513	2468	2379	2310	2458	2377	2382	2442
	Cr		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Cu		<1	<1	<1	<1	<1	<1	<1	<1		1	1	<1	<1	<1	<1	<1	1
	Fe		2	4	4	4	4	2	2	2		3	4	2	2	2	2	3	7
	Pb		<1	<1	1	<1	<1	<1	1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Mg		286	292	291	285	288	279	299	298		258	259	285	282	285	283	294	295
	Mn		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Mo		1	<1	<1	<1	<1	<1	<1	1		2	1	<1	<1	<1	<1	<1	<1
	Ni		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	P		1257	1224	1232	1150	1138	1325	1321	1329		1213	1172	1221	1146	1138	1322	1303	1288
	Si		3	3	3	3	3	5	4	4		3	3	5	5	3	4	4	3
	Ag		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Na		<5	<5	<5	<5	<5	<5	<5	<5		<5	<5	<5	<5	<5	<5	<5	<5
	Sn		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Zn		1455	1494	1434	1433	1411	1417	1472	1462		1408	1433	1417	1415	1408	1408	1446	1441
	K		6	<5	<5	<5	<5	<5	<5	<5		<5	<5	<5	<5	<5	<5	<5	<5
	Sr		<1	<1	<1	1	<1	<1	<1	<1		<1	1	1	1	<1	<1	<1	<1
	V		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Cd		<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	**Inflect**																		
	Buffer		1.93	2.29	2.07	1.84	2.2	2.18	2.17	2.21		1.98	1.86	2.12	1.74	2.06	2.14	2.28	2.51
IR FTNG	**Oxidation**		*							0.22		*							0.66
	Nitration		*							0.09		*							0.28
D6304	**Water Content**		688							728		703							550
D3524	**Fuel Dilution**		*							<0.3		*							<0.3

Table A-27. Ft. Benning, UOA, Stryker

				STRYKER B52										STRYKER B53									
Engine				*Miles*	11674	11781.8	11794.6	11809.7	12000.6	12248.2	12520.8	12536.9		*Miles*	5955	6086.1	6134.8	6164.4	6288.1	6623.9	6716.8	6815.8
				Accum.	-	107.8	120.6	135.7	326.6	574.2	846.8	862.9		*Accum.*	-	131.1	179.8	209.4	333.1	668.9	761.8	860.8
				Hours	1462	1486.9	1493.7	1499.1	1520.4	1555.2	1579.8	1583.1		*Hours*	1431	1469.7	1477.9	1491.2	1524.3	1579.1	1592.6	1614.4
				Accum.	-	24.9	31.7	37.1	58.4	93.2	117.8	121.1		*Accum.*	-	38.7	46.9	60.2	93.3	148.1	161.6	183.4
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*		*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*6th QTR*	*7th QTR*	*8th QTR*
			From:C97320		89.6%	*% initial changeover (calculated from vis)*									87.5%	*% initial changeover (calculated from vis)*						
	D445 100c	Viscosity	8.47	12.5	8.89	8.89	8.88	8.76	9.05	9.45	9.53	9.59		12.3	8.95	8.88	8.92	8.95	8.88	8.83	8.92	9.36
	D445 40c	Viscosity				49.67						56.08			50.25							52.86
	D2270	Viscosity Index				160						156			160							161
	D4739	Buffer	9.49		9.32	9.2	9.08	8.07	7.64	7.72	7.6	7.11			9.24	9.08	8.7	7.39	7.28	7.22	7.43	7
	D5185	Al	2	1	1	2	2	1	2	1	2	2		2	1	2	2	2	2	2	2	3
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	3	14	13	12	12	12	10	10	10		17	16	15	16	14	14	12	12	12
		Ca	902	2548	1163	1207	1203	1143	1257	1403	1462	1435		2363	1169	1189	1171	1084	1145	1167	1256	1285
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	1	1		<1	<1	<1	<1	<1	<1	1	1	2
		Cu	<1	3	<1	1	2	2	2	2	3	3		6	<1	2	3	3	3	3	4	4
		Fe	1	10	2	9	10	10	15	12	17	22		18	4	10	10	10	12	15	19	20
		Pb	<1	<1	<1	<1	<1	<1	<1	<1	2	1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mg	1259	214	1112	1072	1121	1124	1049	958	985	991		387	1118	1108	1143	1106	1102	1099	1127	1113
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	2	55	53	55	53	51	43	44	43		14	57	55	56	53	54	52	54	50
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1191	1124	1091	1097	1043	983	1201	1226	1182		1154	1113	1096	1089	1009	960	1173	1201	1173
		Si	5	3	4	4	4	3	4	4	4	4		5	5	4	4	4	4	4	5	4
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	<5	5	5	5	<5	5	5		6	5	5	5	<5	6	<5	6	5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1388	1318	1336	1303	1274	1282	1275	1347	1320		1351	1303	1345	1297	1232	1263	1260	1329	1314
		K	<5	5	<5	<5	<5	<5	<5	<5	<5	<5		5	5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Inflect																				
		Buffer	1.65		1.93	1.78	1.72	1.5	1.96	1.9	1.83	2.22			1.96	1.78	1.69	1.59	1.89	2.19	1.94	2.23
	IR FTNG	Oxidation				*						1.86			*							2.52
		Nitration				*						0.28			*							0.19
	D6304	Water Content				730						693			692							374
	D3524	Fuel Dilution				*						<0.3			*							<0.3

Table A-28. Ft. Benning, UOA, Stryker (CONT)

				STRYKER B54									STRYKER B55								
				Miles	3013	3085.9	3237.2	3356.1	3478.1	3623.5	3701	3701.1	***Miles***	27731	27731.9	27777	27780.5	27788.4	28013.1	28039	28072.1
				Accum.	-	72.9	224.2	343.1	465.1	610.5	688	688.1	***Accum.***	-	0.9	46	49.5	57.4	282.1	308	341.1
				Hours	584	628.9	654.9	689.8	724.5	775.5	788.6	792.5	***Hours***	2571	2572.4	2581.5	2583	2584.5	2650	2653.5	2673.7
				Accum.	-	44.9	70.9	105.8	140.5	191.5	204.6	208.5	***Accum.***	-	1.4	10.5	12	13.5	79	82.5	102.7
			Fresh Oil	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***6th QTR***	***7th QTR***	***8th QTR***	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***6th QTR***	***7th QTR***	***8th QTR***
			From:C97320		87.8%	*% initial changeover (calculated from vis)*								88.2%	*% initial changeover (calculated from vis)*						
Engine	**D445 100c**	**Viscosity**	8.47	14.28	9.18	9.13	9.22	9.45	9.49	9.17	9.05	10	13.56	9.07	9.07	8.78	8.88	8.85	8.92	9.15	9.34
	D445 40c	**Viscosity**			51.29							59.35		50.78							53.32
	D2270	**Viscosity Index**			162							155		161							159
	D4739	**Buffer**	9.49		9.62	9.24	8.72	8.1	6.85	7.19	6.26	6.23		9.16	9.46	9.35	9.14	8.3	7.87	8.28	7.58
	D5185	**Al**	2	<1	1	2	2	2	2	2	6	5	1	1	2	2	1	2	1	2	2
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	7	15	14	11	10	10	11	9	9	26	18	18	16	16	17	14	14	13
		Ca	902	2397	1172	1237	1283	1269	1395	1242	1324	1488	2308	1132	1186	1152	1055	1135	1214	1243	1328
		Cr	<1	<1	<1	<1	<1	<1	1	1	2	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	2	<1	1	2	2	3	3	7	5	<1	<1	<1	<1	<1	1	2	2	2
		Fe	1	4	2	4	6	8	9	14	24	22	16	4	10	10	9	11	15	19	22
		Pb	<1	1	<1	1	1	2	2	1	3	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mg	1259	321	1120	1055	1032	985	934	1071	1100	981	42	1072	1033	1095	1065	1051	1044	1082	1035
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	4	55	52	48	44	44	50	51	41	8	56	53	55	52	54	51	53	47
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1229	1129	1102	1100	1043	991	1189	1215	1190	1044	1097	1071	1063	983	945	1162	1182	1165
		Si	5	4	5	4	3	3	3	4	5	4	3	4	5	4	4	4	4	5	5
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	5	5	<5	6	<5	6	5	<5	5	5	<5	<5	7	<5	5	5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1435	1325	1344	1311	1267	1299	1270	1347	1325	1184	1281	1302	1254	1198	1241	1238	1296	1289
		K	<5	6	5	<5	<5	<5	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	10	2	2	2	2	2	1	1	1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	**Inflect**																			
		Buffer	1.65		1.89	1.89	1.77	1.78	2.02	2.08	2.17	2.47		1.98	1.74	1.66	1.52	1.62	1.83	1.48	1.97
	IR FTNG	**Oxidation**			*							2.52		*							0.84
		Nitration			*							0.09		*							0.19
	D6304	**Water Content**			790							628		695							409
	D3524	**Fuel Dilution**			*							<0.3		*							1.1

Table A-29. Ft. Benning, UOA, Stryker (CONT)

Control Engine

STRYKER B56

		As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	30172	30213.9	30846.7	31673.8	32170.7	32691.7	32692.5	32709
		Accum.	-	41.9	674.7	1501.8	1998.7	2519.7	2520.5	2537
		Hours	5702	5706.1	5782.6	5882.3	5943.9	6026.4	6029.9	6033.6
		Accum.	-	4.1	80.6	180.3	241.9	324.4	327.9	331.6
D445 100c	Viscosity		12.92	13.02	13.26	13.25	13.18	13.23	13.28	13.45
D445 40c	Viscosity		94.54							98.77
D2270	Viscosity Index		134							136
D4739	Buffer		6.17	6.94	5.58	5.84	5.33	5.87	5.87	5.87
D5185	Al		4	4	2	3	3	2	2	2
	Sb		<1	<1	<1	<1	<1	<1	<1	<1
	Ba		<1	<1	<1	<1	<1	<1	<1	<1
	B		16	15	2	<1	1	2	1	2
	Ca		2204	2245	2378	2332	2426	2328	2429	2465
	Cr		<1	<1	1	2	2	2	2	1
	Cu		4	4	2	4	3	3	3	2
	Fe		8	9	9	15	15	14	16	14
	Pb		<1	1	<1	<1	<1	<1	<1	<1
	Mg		256	262	286	288	292	284	310	300
	Mn		<1	<1	<1	<1	<1	<1	<1	<1
	Mo		9	9	2	1	<1	1	1	<1
	Ni		<1	<1	<1	<1	<1	<1	<1	<1
	P		1121	1097	1201	1132	1077	1288	1320	1296
	Si		4	4	3	4	4	4	4	3
	Ag		<1	<1	<1	<1	<1	<1	<1	<1
	Na		<5	5	<5	<5	5	<5	<5	<5
	Sn		<1	<1	<1	<1	<1	<1	<1	<1
	Zn		1307	1341	1402	1417	1422	1378	1456	1442
	K		6	<5	<5	<5	<5	<5	<5	<5
	Sr		<1	<1	1	1	<1	<1	<1	<1
	V		<1	<1	<1	<1	<1	<1	<1	<1
	Ti		2	2	<1	<1	<1	<1	<1	<1
	Cd		<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Inflect									
	Buffer		1.83	2	2.21	2.3	2.52	2.47	2.3	2.29
IR FTNG	Oxidation		*							0.33
	Nitration		*							0.19
D6304	Water Content		874							375
D3524	Fuel Dilution		*							<0.3

STRYKER B57

		As found	Initial	1st QTR	2nd QTR	3rd QTR	4th QTR	6th QTR	7th QTR	8th QTR
		Miles	30027	30089.4	30274.2	30277.6	30423.7	30707	-	30810
		Accum.	-	62.4	247.2	250.6	396.7	680	-	783
		Hours	4770	4797.9	4818.2	4819.5	4838.6	4874.6	-	4883.7
		Accum.	-	27.9	48.2	49.5	68.6	104.6	-	113.7
D445 100c	Viscosity		12.85	12.8	14.25	14.1	13.43	13.06	Sample Not Available	13.67
D445 40c	Viscosity		93.73					96.15		
D2270	Viscosity Index		134					134		
D4739	Buffer		7.23	8.2	8.64	8.87	7.89	7.09		
D5185	Al		1	2	<1	<1	1	1		<1
	Sb		<1	<1	<1	<1	<1	<1		<1
	Ba		<1	<1	<1	<1	<1	<1		<1
	B		2	2	<1	<1	<1	1		<1
	Ca		2431	2494	2399	2320	2413	2352		2405
	Cr		<1	<1	<1	<1	<1	<1		<1
	Cu		1	1	<1	<1	<1	1		<1
	Fe		14	15	4	7	13	18		7
	Pb		<1	<1	<1	<1	<1	<1		<1
	Mg		273	281	291	286	288	278		293
	Mn		<1	<1	<1	<1	<1	<1		<1
	Mo		1	<1	<1	<1	<1	<1		<1
	Ni		<1	<1	<1	<1	<1	<1		<1
	P		1229	1192	1229	1152	1085	1301		1283
	Si		3	3	3	3	2	3		3
	Ag		<1	<1	<1	<1	<1	<1		<1
	Na		<5	<5	<5	<5	6	<5		<5
	Sn		<1	<1	<1	<1	<1	<1		<1
	Zn		1434	1460	1425	1418	1423	1383		1409
	K		<5	<5	<5	<5	<5	<5		<5
	Sr		<1	<1	<1	1	<1	<1		<1
	V		<1	<1	<1	<1	<1	<1		<1
	Ti		<1	<1	<1	<1	<1	<1		<1
	Cd		<1	<1	<1	<1	<1	<1		<1
D664 Acid	Inflect									
	Buffer		1.89	1.89	2.17	1.83	1.87	1.96		
IR FTNG	Oxidation		*					0.58		
	Nitration		*					0		
D6304	Water Content		810					685		
D3524	Fuel Dilution		*					<0.3		

APPENDIX B.

Ft. Wainwright Field Demo Raw Data

Table B-1. Ft. Wainwright, Vehicle Utilization, HMMWV

HMMWV

	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	
TEST	**BSMC-101**	27214		27270		27303		27410		27411		**Recordings**
TEST	**BSMC-104**	26		35		46		194		1078		
CONTROL	**BSMC-105**	17194		17212		17226		17634		17945		
CONTROL	**BSMC-113**	16080		16409		16439		16664		17088		
TEST	**BSMC-101**			57		33		107		2		**Accumulation by Quarter**
TEST	**BSMC-104**			9		11		147		884		
CONTROL	**BSMC-105**			18		14		408		312		
CONTROL	**BSMC-113**			329		30		225		424		
TEST	**BSMC-101**			57		89		196		198		**Total Accumulation**
TEST	**BSMC-104**			9		20		168		1052		
CONTROL	**BSMC-105**			18		32		439		751		
CONTROL	**BSMC-113**			329		359		583		1008		

Note: No hr meter readings

Table B-2. Ft. Wainwright, Vehicle Utilization, HEMTT

HEMTT

	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	DC-111	110	46	245	103	246	192	341	241	1758	352	Recordings
TEST	DC-113	399	85	1360	215	1360	243	1439	264	1588	300	
CONTROL	DC-112	98		306	102	705	218	1030	336	2001	420	
CONTROL	DC-114	423	77	430	84	432	137	432	144	866	197	
TEST	DC-111			134	57	2	90	94	48	1417	112	Accumulation by Quarter
TEST	DC-113			961	130	0	28	80	21	149	35	
CONTROL	DC-112			208		399	116	324	117	971	84	
CONTROL	DC-114			7	7	2	53	0	7	435	53	
TEST	DC-111			134	57	136	147	230	195	1648	307	Total Accumulation
TEST	DC-113			961	130	961	159	1041	180	1190	215	
CONTROL	DC-112			208		607	218	932	336	1903	420	
CONTROL	DC-114			7	7	8	60	8	67	443	120	

Table B-3. Ft. Wainwright, Vehicle Utilization, MTV

MTV

	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	
TEST	HQ-31	1883		1904		1908		2033		2327		Recordings
TEST	HQ-32	756		762		777		778		1155		
CONTROL	HHC-153	5328		5329		5335		5718		6345		
CONTROL	HHC-112	6986		6986		6986		6986		6986		
TEST	HQ-31			21		4		125		294		Accumulation by Quarter
TEST	HQ-32			6		15		1		377		
CONTROL	HHC-153			0		7		383		626		
CONTROL	HHC-112			1		0		0		0		
TEST	HQ-31			21		25		150		444		Total Accumulation
TEST	HQ-32			6		21		22		399		
CONTROL	HHC-153			0		7		390		1016		
CONTROL	HHC-112			1		1		1		1		

****Note: No hr meter readings***

Table B-4. Ft. Wainwright, Vehicle Utilization, SUS-V

SUS-V

	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		
		Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	NWTC-2	6988		7086		7086		7210		7220		Recordings
TEST	NWTC-3	4588		4686		5042		5449		5456		
CONTROL	NWTC-4	4945		5179		5742		6052		6323		
CONTROL	NWTC-34	4157		4260		4517		4661		4754		
TEST	NWTC-2			98		0		124		10		Accumulation by Quarter
TEST	NWTC-3			98		356		407		7		
CONTROL	NWTC-4			234		563		310		271		
CONTROL	NWTC-34			103		257		144		93		
TEST	NWTC-2			98		98		222		232		Total Accumulation
TEST	NWTC-3			98		454		861		868		
CONTROL	NWTC-4			234		797		1107		1378		
CONTROL	NWTC-34			103		360		504		597		

Note: SUS-V mileage accumulation listed in kilometers (km), No hr meter readings

Table B-5. Ft. Wainwright, UOA, HMMWV

				HMMWV BSCM-101						HMMWV BSMC-104					
				ENGINE						ENGINE					
				Miles	27213.5	27270.2	27302.7	27409.5	27411	*Miles*	26	35.4	46.2	193.5	1077
				Accum.	-	56.7	89.2	196	197.5	*Accum.*	-	9.4	20.2	167.5	1051
				Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
				Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
			From:C97320		89.5%	*% initial changeover (calculated from Mg)*					74.2%	*% initial changeover (calculated from Mg)*			
TEST	D445 100c	Viscosity	8.47	9.87	8.67	8.46	8.89	8.92	8.7	10.11	8.75	8.78	9.02	8.98	9.36
	D445 40c	Viscosity			47.62				47.82		47.28				52.33
	D2270	Viscosity Index			162				162		167				164
	D4739	Buffer	9.49		9.18		8.56		IC		9.43		8.7		IC
	D5185	Al	2	2	1	2	4	5	4	2	1	2	3	4	7
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	<1	12	16	13	11	17	6	12	14	14	14	13
		Ca	902	3361	1280	1105	1519	1671	1624	3139	1556	1502	1538	1391	1587
		Cr	<1	<1	<1	2	4	5	5	3	<1	8	17	20	22
		Cu	<1	<1	<1	<1	<1	1	2	2	3	1	2	2	5
		Fe	1	12	4	12	39	51	51	23	2	21	62	94	127
		Pb	<1	4	<1	<1	3	4	6	4	<1	2	3	4	9
		Mg	1259	18	1129	1261	1068	1005	945	121	965	1047	1031	1141	1139
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
		Mo	64	<1	53	63	56	52	51	2	46	51	53	59	67
		Ni	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	1	1	3
		P	1079	1211	1070	1183	951	1219	1181	1164	1091	1184	969	1188	1217
		Si	5	10	7	36	44	44	46	21	9	12	18	19	29
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	<5	5	5	6	6	5	<5	9	6	6	7
		Sn	<1	<1	<1	<1	<1	<1	<1	3	<1	3	6	8	12
		Zn	1265	1418	1284	1262	1328	1304	1235	1376	1294	1314	1322	1297	1340
		K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	1	<1	<1	2	<1	<1	<1	<1	<1	1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Buffer	1.65		1.74		1.83		1.89		1.73		1.52		2.35
	IR FTNG	Oxidation			0				3.88		0				1.11
		Nitration			0				0.28		0				0.74
	D6304	Water Content			1148				1406		881				564
	D3524	Fuel Dilution			<0.3				<0.3		<0.3				<0.3

Table B-6. Ft. Wainwright, UOA, HMMWV (CONT)

				HMMWV BSCM-101						HMMWV BSMC-104					
				TRANSMISSION						TRANSMISSION					
				Miles	27213.5	27270.2	27302.7	27409.5	27411	*Miles*	26	35.4	46.2	193.5	1077
				Accum.	-	56.7	89.2	196	197.5	*Accum.*	-	9.4	20.2	167.5	1051
				Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
				Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
			From:C97320		66.1%	*% initial changeover (calculated from Mg)*					83.2%	*% initial changeover (calculated from Mg)*			
TEST	D445 100c	Viscosity	8.47	9.05	8.72	8.45	8.31	8.39	8.19	9.43	8.92	8.49	8.62	8.34	8.48
	D445 40c	Viscosity			47.61				45.58		48.59				45.98
	D2270	Viscosity Index			164				155		166				164
	D4739	Buffer	9.49		9.24		8.83		IC		9.22		9.11		IC
	D5185	Al	2	1	<1	1	1	1	1	1	1	1	1	1	2
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	14	15	17	17	16	19	5	13	13	12	14	15
		Ca	902	2723	1565	1754	1730	1737	1713	2961	1416	1927	1878	1805	1765
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	10	4	5	5	5	5	10	<1	5	5	5	6
		Fe	1	5	3	3	4	4	3	4	7	3	4	4	4
		Pb	<1	1	<1	<1	2	<1	2	1	<1	<1	<1	2	2
		Mg	1259	39	846	838	791	824	804	64	1058	841	787	790	888
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	<1	41	39	38	39	37	<1	49	39	38	37	42
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1053	1039	1198	933	1183	1143	1135	1084	1249	947	1192	1204
		Si	5	8	7	6	6	6	6	15	10	11	10	10	10
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	6	5	5	5	<5	<5	6	<5	5	<5
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1197	1216	1259	1259	1241	1242	1320	1293	1331	1324	1252	1297
		K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	2	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Buffer	1.65		1.71		1.84		1.89		1.74		1.88		1.77
	IR FTNG	Oxidation				*Did not analyze*					*Did not analyze*				
		Nitration													
	D6304	Water Content			987				612		938				697
	D3524	Fuel Dilution				*Not Applicable*					*Not Applicable*				

Table B-7. Ft. Wainwright, UOA, HMMWV (CONT)

Control

			HMMWV BSCM-105 ENGINE						HMMWV BSMC-113 ENGINE				
		Miles	17194.1	17212	17226	17633.5	17945	Miles	16080.4	16409	16439	16663.8	17088
		Accum.	-	17.9	31.9	439.4	750.9	Accum.	-	328.6	358.6	583.4	1007.6
		Hours	-	-	-	-	-	Hours	-	-	-	-	-
		Accum.	-	-	-	-	-	Accum.	-	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
D445 100c	Viscosity		10.3	*Sample Not Available*	10.04	9.83	9.72		9.64	*Sample Not Available*	9.74	9.31	9.57
D445 40c	Viscosity		56.74				54.57		52.93				54.44
D2270	Viscosity Index		172				165		169				161
D4739	Buffer		8.78		7.2		7.24		9.58		8.65		6.92
D5185	Al		4		8	10	10		2		2	2	4
	Sb		<1		<1	<1	<1		<1		<1	1	1
	Ba		<1		<1	<1	<1		<1		<1	<1	<1
	B		1		2	1	4		<1		<1	<1	9
	Ca		3442		3614	3909	3928		3254		3431	3440	3458
	Cr		5		14	17	16		<1		2	5	7
	Cu		2		4	5	5		<1		13	16	18
	Fe		33		79	138	113		5		20	34	47
	Pb		6		11	16	18		4		31	43	72
	Mg		44		48	35	28		15		30	31	28
	Mn		<1		<1	1	1		<1		1	2	2
	Mo		<1		<1	<1	<1		<1		<1	<1	<1
	Ni		<1		<1	<1	<1		<1		<1	<1	<1
	P		1236		1059	1397	1390		1187		1037	1324	1329
	Si		46		55	39	36		32		52	66	79
	Ag		<1		<1	<1	<1		<1		<1	<1	<1
	Na		<5		5	6	6		<5		11	16	17
	Sn		2		5	7	7		<1		7	12	16
	Zn		1485		1507	1545	1526		1391		1466	1426	1393
	K		<5		<5	<5	6		<5		<5	<5	6
	Sr		1		2	1	1		1		2	1	1
	V		<1		<1	<1	<1		<1		<1	<1	<1
	Ti		<1		<1	<1	<1		<1		<1	<1	<1
	Cd		<1		<1	<1	<1		<1		<1	<1	4
D664 Acid	Buffer		2.13		2.46		2.92		2.28		2.3		2.55
IR FTNG	Oxidation		0				2.13		0				1.29
	Nitration		0				0.83		0				0.46
D6304	Water Content		972				1293		1605				1539
D3524	Fuel Dilution		<0.3				<0.3		<0.3				<0.3

Table B-8. Ft. Wainwright, UOA, HMMWV (CONT)

Control			HMMWV BSCM-105 TRANSMISSION						HMMWV BSMC-113 TRANSMISSION				
		Miles	17194.1	17212	17226	17633.5	17945	*Miles*	16080.4	16409	16439	16663.8	17088
		Accum.	-	17.9	31.9	439.4	750.9	*Accum.*	-	328.6	358.6	583.4	1007.6
		Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
		Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
D445 100c	Viscosity		8.17	*Sample Not Available*	7.97	7.74	7.52		9.45	*Sample Not Available*	8.65	8.52	8.37
D445 40c	Viscosity		42.84				40.9		50.67				44.69
D2270	Viscosity Index		168				153		173				166
D4739	Buffer		6.08		5.67		8.3		9.33		8.26		8.77
D5185	Al		1		1	1	1		1		1	1	1
	Sb		<1		<1	1	1		<1		<1	<1	<1
	Ba		2		2	2	2		<1		<1	<1	<1
	B		39		42	41	46		7		14	19	21
	Ca		2086		2195	2174	2063		3098		3111	2847	2800
	Cr		<1		<1	<1	<1		<1		<1	<1	<1
	Cu		14		16	18	19		14		19	17	22
	Fe		10		10	14	14		4		4	4	4
	Pb		9		10	11	11		2		3	4	5
	Mg		13		15	14	15		53		51	45	46
	Mn		<1		<1	<1	<1		<1		<1	<1	<1
	Mo		<1		<1	<1	<1		<1		<1	<1	<1
	Ni		<1		<1	<1	<1		<1		<1	<1	<1
	P		829		925	932	875		1164		1254	1181	1151
	Si		9		8	9	9		14		14	14	15
	Ag		<1		<1	<1	<1		<1		<1	<1	<1
	Na		7		9	8	7		<5		<5	<5	5
	Sn		<1		<1	<1	<1		<1		<1	<1	<1
	Zn		898		910	888	847		1364		1320	1186	1189
	K		5		5	6	6		<5		5	<5	5
	Sr		<1		<1	<1	<1		1		1	<1	<1
	V		<1		<1	<1	<1		<1		<1	<1	<1
	Ti		<1		<1	<1	<1		<1		<1	<1	<1
	Cd		<1		<1	<1	<1		<1		<1	<1	<1
D664 Acid	Buffer		1.19		1.39		1.02		2.07		2.08		1.57
IR FTNG	Oxidation		*Did not analyze*						*Did not analyze*				
	Nitration												
D6304	Water Content		1156				797		1072				940
D3524	Fuel Dilution		*Not Applicable*						*Not Applicable*				

Table B-9. Ft. Wainwright, UOA, HEMTT

TEST			HEMTT DC-111 ENGINE						HEMTT DC-113 ENGINE					
			Miles	110.4	244.7	246.4	340.5	1757.9	***Miles***	398.5	1359.6	1359.7	1439.4	1588.1
			Accum.	-	134.3	136	230.1	1647.5	***Accum.***	-	961.1	961.2	1040.9	1189.6
			Hours	45.55	102.8	192.4	240.5	352.2	***Hours***	84.55	214.6	243.05	264.3	299.5
			Accum.	-	57.25	146.85	194.95	306.65	***Accum.***	-	130.05	158.5	179.75	214.95
		Fresh Oil	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***
		From:C97320		78.4%	*% initial changeover (calculated from Mg)*					78.2%	*% initial changeover (calculated from Mg)*			
D445 100c	**Viscosity**	8.47	8.72	8.65		8.53	8.07	8.29	7.64	8.83	8.35	7.94	8.19	7.82
D445 40c	**Viscosity**			46.19				44.81		48.21				41.66
D2270	**Viscosity Index**			168				163		165				161
D4739	**Buffer**	9.49		9.83		8.29		6.42		9.66	8.41	6.54		6.79
D5185	**Al**	2	1	<1	2	2	2	3	1	1	2	3	3	4
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	4	13	13	12	12	12	19	18	15	16	15	16
	Ca	902	3081	1455	1428	1527	1450	1500	2914	1461	1409	1488	1081	1110
	Cr	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
	Cu	<1	17	5	11	14	18	45	58	<1	27	201	85	96
	Fe	1	8	3	11	18	24	32	13	3	20	36	28	34
	Pb	<1	<1	<1	<1	<1	2	2	2	<1	1	2	<1	<1
	Mg	1259	11	990	983	933	957	962	14	988	1012	939	1193	1198
	Mn	<1	<1	<1	<1	<1	1	1	1	<1	1	2	1	1
	Mo	64	<1	47	50	47	46	48	23	53	56	54	61	62
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1095	1053	1064	904	1138	1145	1026	1055	1140	938	1136	1141
	Si	5	32	13	17	18	20	32	38	7	22	25	14	17
	Ag	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
	Na	<5	<5	<5	6	<5	5	6	<5	<5	6	<5	5	7
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1280	1271	1268	1252	1209	1223	1199	1260	1253	1233	1215	1220
	K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	2	<1	<1	1	<1	<1	2	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	**Buffer**	1.65		1.6		1.82		2.17		1.74	2.02	1.79		1.86
IR FTNG	**Oxidation**			0				1.76		0				N/A
	Nitration			0				0		0				N/A
D6304	**Water Content**			986				1192		641				1562
D3524	**Fuel Dilution**			<0.3				2		<0.3		1.2		1.2

Table B-10. Ft. Wainwright, UOA, HEMTT (CONT)

				HEMTT DC-111						HEMTT DC-113					
				TRANSMISSION						TRANSMISSION					
				Miles	110.4	244.7	246.4	340.5	1757.9	*Miles*	398.5	1359.6	1359.7	1439.4	1588.1
				Accum.	-	134.3	136	230.1	1647.5	*Accum.*	-	961.1	961.2	1040.9	1189.6
				Hours	45.55	102.8	192.4	240.5	352.2	*Hours*	84.55	214.6	243.05	264.3	299.5
				Accum.	-	57.25	146.85	194.95	306.65	*Accum.*	-	130.05	158.5	179.75	214.95
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
			From:C97320		84.8%	*% initial changeover (calculated from Mg)*					83.1%	*% initial changeover (calculated from Mg)*			
TEST	D445 100c	Viscosity	8.47	10.04	8.87	8.6	8.39	8.43	8.16	9.6	8.41	8.24	8.39	8.15	8.29
	D445 40c	Viscosity			48.18				46.62		44.21				46.36
	D2270	Viscosity Index			166				158		170				163
	D4739	Buffer	9.49		9.45		8.74		5.25		9.28		8.99		7.24
	D5185	Al	2	2	<1	2	1	2	2	2	<1	3	3	3	3
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	11	15	16	15	15	14	26	16	20	19	21	19
		Ca	902	2903	1252	1684	1675	1631	1704	2924	1291	1652	1801	1727	1806
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	2	<1	1	1	2	2	2	12	1	2	2	2
		Fe	1	5	2	4	4	6	8	6	4	10	8	10	10
		Pb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
		Mg	1259	9	1069	870	835	855	896	11	1048	841	822	836	877
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	<1	51	44	42	42	44	24	55	52	50	50	52
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1049	1042	1190	934	1157	1169	1039	1028	1077	914	1170	1179
		Si	5	6	6	6	6	6	6	7	13	6	7	7	7
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	6	<5	6	5	6	5	8	6	8	8
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1217	1220	1248	1250	1213	1262	1190	1223	1262	1265	1232	1277
		K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5
		Sr	<1	1	<1	<1	2	<1	<1	<1	<1	<1	2	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Buffer	1.65		1.56		1.52		1.71		1.61		1.82		1.72
	IR FTNG	Oxidation			*Did not analyze*						*Did not analyze*				
		Nitration													
	D6304	Water Content			830				799		935				839
	D3524	Fuel Dilution			*Not Applicable*						*Not Applicable*				

Table B-11. Ft. Wainwright, UOA, HEMTT (CONT)

Control

		HEMTT DC-112 (Fomerly DC-110) ENGINE						HEMTT DC-114 ENGINE					
		Miles		306.3	705.3	1029.6	2001	Miles	423.2	430	431.3	431.5	866
		Accum.	-	306.3	705.3	1029.6	2001	Accum.	-	6.8	8.1	8.3	442.8
		Hours		102.3	218.25	335.65	419.8	Hours	77.1	84.3	137.1	143.6	196.9
		Accum.	-	102.3	218.25	335.65	419.8	Accum.	-	7.2	60	66.5	119.8
			Initial	1st QTR	2nd QTR	3rd QTR	4th QTR		Initial	1st QTR	2nd QTR	3rd QTR	4th QTR
D445 100c	Viscosity		Initial Sample Not Available - Vehicle Switch	8.46	8.5	8.14	9.16		8.62	8.37	8.5	7.96	8.31
D445 40c	Viscosity						52.35		44.56				44.82
D2270	Viscosity Index						158		175				163
D4739	Buffer				7		6		9.4		8.61		7.36
D5185	Al			1	2	2	2		6	4	6	8	9
	Sb			<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ba			<1	<1	<1	<1		<1	<1	<1	<1	<1
	B			1	<1	1	2		7	9	8	9	9
	Ca			3249	3278	3080	2810		3206	3358	3367	3209	3375
	Cr			<1	<1	1	<1		<1	<1	<1	<1	<1
	Cu			34	162	269	429		9	12	17	19	36
	Fe			18	36	41	39		6	6	11	15	18
	Pb			3	4	4	4		<1	<1	1	1	2
	Mg			17	16	15	189		13	13	13	14	17
	Mn			1	2	3	2		<1	<1	<1	<1	1
	Mo			<1	<1	<1	9		9	10	9	9	10
	Ni			<1	<1	<1	<1		<1	<1	<1	<1	<1
	P			1193	999	1169	1178		1129	1245	1017	1236	1272
	Si			44	47	48	45		25	28	31	32	41
	Ag			<1	<1	1	1		<1	<1	<1	<1	<1
	Na			7	<5	<5	8		6	8	6	7	10
	Sn			2	2	3	2		<1	<1	<1	1	2
	Zn			1291	1307	1236	1260		1333	1338	1342	1285	1331
	K			<5	<5	<5	<5		<5	<5	<5	<5	5
	Sr			1	2	1	1		1	1	3	1	1
	V			<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ti			<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cd			<1	<1	<1	<1		<1	<1	<1	<1	<1
D664 Acid	Buffer				1.99		1.87		1.79		1.86		2.09
IR FTNG	Oxidation						N/A		0				0
	Nitration						N/A		0				0
D6304	Water Content						1255		1265				1328
D3524	Fuel Dilution						1.2		1.5				1

Table B-12. Ft. Wainwright, UOA, HEMTT (CONT)

Control			HEMTT DC-112 (Fomerly DC-110)						HEMTT DC-114				
			TRANSMISSION						TRANSMISSION				
			Miles	0	306.3	705.3	1029.6	2001	*Miles*	423.2	430	431.3	431.5	866
			Accum.	-	306.3	705.3	1029.6	2001	*Accum.*	-	6.8	8.1	8.3	442.8
			Hours	0	102.3	218.25	335.65	419.8	*Hours*	77.1	84.3	137.1	143.6	196.9
			Accum.	-	102.3	218.25	335.65	419.8	*Accum.*	-	7.2	60	66.5	119.8
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
D445 100c	Viscosity			Initial Sample Not Available - Vehicle Switch	9.53	9.15	8.77	8.51		9.56	9.26	8.91	9.02	8.83
D445 40c	Viscosity							49.13		52.99				48.96
D2270	Viscosity Index							151		167				162
D4739	Buffer					7.92		8.56		10.08		8.98		8.76
D5185	Al				2	2	2	3		2	2	2	2	3
	Sb				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ba				1	1	1	<1		<1	<1	<1	<1	<1
	B				14	14	14	8		9	11	11	11	12
	Ca				3065	2884	3011	3341		3294	3454	3331	3447	3470
	Cr				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cu				4	6	6	5		<1	1	1	1	2
	Fe				5	8	8	10		4	4	4	4	6
	Pb				1	2	3	2		<1	<1	<1	<1	1
	Mg				8	7	8	9		10	10	9	10	10
	Mn				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Mo				<1	<1	<1	<1		10	10	9	9	10
	Ni				<1	<1	<1	<1		<1	<1	<1	<1	<1
	P				1163	1145	1165	1256		1156	1273	1284	1286	1290
	Si				4	5	4	5		6	5	5	4	5
	Ag				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Na				6	5	6	6		5	7	6	7	6
	Sn				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Zn				1241	1166	1224	1351		1366	1382	1323	1384	1396
	K				5	<5	<5	<5		<5	<5	<5	<5	<5
	Sr				<1	<1	<1	1		2	1	1	1	1
	V				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ti				<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cd				<1	<1	<1	<1		<1	<1	<1	<1	<1
D664 Acid	Buffer					1.83		2.1		2.13		2.28		2.14
IR FTNG	Oxidation				*Did not analyze*					*Did not analyze*				
	Nitration													
D6304	Water Content							760		894				894
D3524	Fuel Dilution				*Not Applicable*					*Not Applicable*				

Table B-13. Ft. Wainwright, UOA, SUS-V

				SUS-V NWTC-2						SUS-V NWTC-3					
				ENGINE						ENGINE					
				km	6988	7086	7086	7210	7220	*km*	4588	4656	5042	5449	5456
				Accum.	-	98	98	222	232	*Accum.*	-	68	454	861	868
				Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
				Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
			From:C97320		99.3%	*% initial changeover (calculated from Mg)*					94.9%	*% initial changeover (calculated from Mg)*			
TEST	D445 100c	Viscosity	8.47	10.42	8.75	9.01	9.41	9.55	9.45	14.05	8.93	9.61	10.14	10.52	10.02
	D445 40c	Viscosity			46.94				55.29		50.57				59.25
	D2270	Viscosity Index			168				155		158				156
	D4739	Buffer	9.49		9.62		7.44		8.24		8.55		6.79		9.04
	D5185	Al	2	4	1	2	3	3	3	9	2	4	6	6	6
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	2
		Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		B	14	6	15	13	16	16	19	72	22	27	27	29	31
		Ca	902	3218	1087	1286	1530	1502	1526	2790	1105	1309	1407	1322	1306
		Cr	<1	3	<1	1	2	3	3	5	<1	2	3	4	3
		Cu	<1	2	<1	1	2	2	3	5	<1	2	3	3	4
		Fe	1	46	6	19	30	40	38	107	13	34	53	63	61
		Pb	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	1	1	<1
		Mg	1259	37	1250	1114	954	1013	1006	50	1197	1071	1060	1162	1155
		Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Mo	64	9	60	58	53	55	56	68	65	67	71	72	75
		Ni	<1	1	<1	<1	1	2	2	3	<1	1	2	2	2
		P	1079	1164	1062	1080	895	1158	1165	1097	1054	1167	901	1158	1166
		Si	5	6	6	5	5	6	6	10	7	7	8	8	10
		Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	<5	5	6	<5	<5	5	5	5	<5	5	7	6
		Sn	<1	1	<1	<1	<1	<1	<1	3	<1	<1	<1	<1	<1
		Zn	1265	1373	1296	1294	1279	1276	1273	1408	1297	1282	1334	1312	1299
		K	<5	25	<5	8	8	10	13	14	<5	5	7	7	8
		Sr	<1	1	<1	<1	2	<1	<1	1	<1	<1	2	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Buffer	1.65		1.7		1.92		2.17		1.86		2.04		2.35
	IR FTNG	Oxidation			0				3.23		0				3.51
		Nitration			0				1.29		0				1.39
	D6304	Water Content			1049				2451		946				2782
	D3524	Fuel Dilution			<0.3				<0.3		<0.3				<0.3

Table B-14. Ft. Wainwright, UOA, SUS-V (CONT)

Control

		SUS-V NWTC-4 ENGINE						SUS-V NWTC-34 ENGINE					
		km	4945	5179	5742	6052	6323	*km*	4157	4260	4517	4661	4754
		Accum.	-	234	797	1107	1378	*Accum.*	-	103	360	504	597
		Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
		Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
D445 100c	**Viscosity**		7.93	9.2	12.2	13.06	12.2		10.38	10.05	10.57	10.7	11.27
D445 40c	**Viscosity**		38.58				84.6		59.2				72.14
D2270	**Viscosity Index**		184				139		166				148
D4739	**Buffer**		7.79		6.48		7.94		7.11		6.67		8.76
D5185	**Al**		9	10	9	8	7		8	6	6	7	6
	Sb		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ba		<1	<1	<1	<1	<1		14	14	8	8	6
	B		9	11	24	28	30		28	31	26	26	26
	Ca		2777	2464	2597	2543	2300		2577	2727	2219	2193	2204
	Cr		5	5	6	5	4		4	3	3	4	3
	Cu		4	5	4	4	3		5	6	4	4	4
	Fe		48	60	71	73	60		56	50	60	68	55
	Pb		5	5	3	2	2		<1	1	<1	1	<1
	Mg		114	461	244	170	353		111	115	344	342	328
	Mn		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Mo		15	36	24	18	31		14	13	27	29	24
	Ni		5	5	5	4	2		5	4	4	4	3
	P		1000	1073	890	1127	1127		1082	1184	897	1120	1130
	Si		16	16	14	13	11		12	11	11	12	10
	Ag		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Na		8	9	7	7	6		<5	<5	<5	5	<5
	Sn		2	2	2	2	1		2	<1	<1	<1	<1
	Zn		1249	1334	1310	1263	1238		1269	1292	1246	1229	1220
	K		16	14	12	12	12		7	10	8	8	10
	Sr		1	<1	3	<1	<1		1	1	3	<1	<1
	V		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cd		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
D664 Acid	**Buffer**		1.71		2.07		2.38		1.93		1.9		1.92
IR FTNG	**Oxidation**		0				8.04		0				4.16
	Nitration		0				0		0				0
D6304	**Water Content**		1327				1803		1322				2238
D3524	**Fuel Dilution**		0.8				<0.3		<0.3				<0.3

Table B-15. Ft. Benning, UOA, MTV

TEST			MTV HQ-31 ENGINE						MTV HQ-32 ENGINE					
			Miles	1883	1904	1908	2033	2327	*Miles*	756	762	777	778	1155
			Accum.	-	21	25	150	444	*Accum.*	-	6	21	22	399
			Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
			Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
		Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
		From:C97320		85.2%	*% initial changeover (calculated from Mg)*					94.7%	*% initial changeover (calculated from Mg)*			
D445 100c	Viscosity	8.47	8.99	8.69	8.28	8.34	8.27	8.21	9.23	8.57	8.34	8.28	8.26	8.16
D445 40c	Viscosity			46.16				44.39		46.83				44.92
D2270	Viscosity Index			170				162		163				157
D4739	Buffer	9.49		9.14		9.11		5.3		9.37		9.1		7.52
D5185	Al	2	2	<1	2	1	2	2	2	1	2	1	2	2
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	14	15	16	17	14	13	14	15	17	17	17	16
	Ca	902	3265	1373	1438	1404	1775	1833	3358	1179	1203	1263	1193	1296
	Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1
	Cu	<1	17	4	6	8	7	8	7	<1	3	2	3	4
	Fe	1	12	4	6	8	11	14	6	2	3	5	5	8
	Pb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mg	1259	16	1075	1071	1028	880	884	14	1193	1163	1160	1175	1156
	Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mo	64	<1	51	52	52	43	44	<1	57	57	59	58	56
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1121	1067	1159	917	1219	1232	1199	1073	1154	931	1167	1190
	Si	5	14	8	8	7	7	9	12	7	6	7	7	9
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	<5	<5	5	5	10	11	7	5	<5	5	6	7
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1333	1287	1300	1278	1305	1309	1419	1285	1275	1296	1245	1271
	K	<5	<5	<5	<5	<5	<5	5	<5	<5	<5	<5	<5	<5
	Sr	<1	1	<1	<1	2	<1	<1	1	<1	<1	2	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Buffer	1.65		1.77		1.67		1.9		1.75		1.28		1.73
IR FTNG	Oxidation			0				1.29		0				0.88
	Nitration			0				0.18		0				0
D6304	Water Content			1333				1259		1028				1331
D3524	Fuel Dilution			<0.3				<0.3		<0.3				<0.3

Table B-16. Ft. Benning, UOA, MTV (CONT)

TEST			MTV HQ-31 TRANSMISSION						MTV HQ-32 TRANSMISSION					
			Miles	1883	1904	1908	2033	2327	*Miles*	756	762	777	778	1155
			Accum.	-	21	25	150	444	*Accum.*	-	6	21	22	399
			Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
			Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
		Fresh Oil	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***	***As found***	***Initial***	***1st QTR***	***2nd QTR***	***3rd QTR***	***4th QTR***
		From:C97320		58.6%	*% initial changeover (calculated from Mg)*					57.3%	*% initial changeover (calculated from Mg)*			
D445 100c	**Viscosity**	8.47	9.04	8.65	8.19	8.12	8.03	7.86	8.88	8.49	8.21	8.36	8.18	8.28
D445 40c	**Viscosity**			45.44				43.6		44.46				43.99
D2270	**Viscosity Index**			172				172		171				166
D4739	**Buffer**	9.49		9.06		8.54		8.5		8.51		8.05		8.96
D5185	**Al**	2	2	1	2	2	2	2	3	2	2	2	2	2
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1	<1
	B	14	103	45	41	39	43	42	177	89	77	73	76	77
	Ca	902	2537	1707	1613	1645	1651	1667	2194	1459	1464	1409	1420	1446
	Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cu	<1	113	68	51	57	58	55	202	116	99	97	96	110
	Fe	1	12	7	6	8	9	10	19	10	8	11	11	12
	Pb	<1	4	1	<1	1	2	2	4	2	1	2	2	2
	Mg	1259	10	742	867	857	889	889	11	726	907	858	894	899
	Mn	<1	1	<1	<1	<1	<1	<1	2	1	<1	<1	1	1
	Mo	64	4	38	44	44	44	42	6	39	47	46	46	45
	Ni	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	1	<1	<1
	P	1079	832	1019	1118	916	1164	1129	764	954	1117	878	1108	1082
	Si	5	29	8	6	8	8	7	19	10	8	9	10	10
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	6	5	<5	5	5	<5	6	5	6	<5	5	<5
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1310	1223	1261	1259	1245	1315	1226	1161	1229	1204	1196	1270
	K	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Sr	<1	<1	<1	<1	2	<1	<1	<1	<1	<1	2	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	4	2	2	2	2	3	7	4	4	4	4	5
D664 Acid	**Buffer**	1.65		1.6		1.7		1.58		1.45		1.52		1.36
IR FTNG	**Oxidation**			*Did not analyze*						*Did not analyze*				
	Nitration													
D6304	**Water Content**			1073				1344		1174				1327
D3524	**Fuel Dilution**			*Not Applicable*						*Not Applicable*				

Table B-17. Ft. Benning, UOA, MTV (CONT)

			MTV HHC-111 (153)						MTV HHC-112				
			ENGINE						ENGINE				
			Miles	5328.1	5328.5	5335	5335	6344.5	*Miles*	6985.6	6986.2	6986.2	6986	6986.2
			Accum.	-	0.4	6.9	6.9	1016.4	*Accum.*	-	0.6	0.6	0.4	0.6
			Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
			Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
				Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
Control	D445 100c	Viscosity		9.2	8.64	9.11	8.3	8.37		9.21	9.01	9.07	8.9	8.8
	D445 40c	Viscosity		49.01				45.17		50.08				49.07
	D2270	Viscosity Index		173				164		168				160
	D4739	Buffer		10.09		9.43		7.99		9.74		8.9		8.01
	D5185	Al		1	1	1	2	2		2	1	2	1	1
		Sb		<1	<1	<1	<1	<1		1	1	1	1	<1
		Ba		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		B		<1	2	<1	<1	<1		<1	1	<1	1	1
		Ca		3447	3592	3789	3593	3754		3444	3577	3555	3440	3596
		Cr		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Cu		2	7	<1	3	4		2	3	3	3	8
		Fe		5	6	7	11	21		6	5	6	6	6
		Pb		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Mg		9	13	10	10	13		14	14	16	14	14
		Mn		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Mo		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Ni		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		P		1222	1367	1108	1394	1414		1245	1390	1076	1377	1394
		Si		5	4	5	5	6		5	4	4	4	4
		Ag		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Na		7	10	23	20	24		<5	6	<5	<5	5
		Sn		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Zn		1448	1433	1517	1455	1498		1465	1436	1466	1416	1451
		K		<5	<5	7	6	8		<5	<5	<5	<5	5
		Sr		1	1	3	1	1		1	1	3	1	1
		V		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Ti		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
		Cd		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	D664 Acid	Buffer		2.35		2.44		2.68		2.28		2.18		2.23
	IR FTNG	Oxidation		0				0		0				0
		Nitration		0				0		0				0
	D6304	Water Content		1144				1289		1234				1410
	D3524	Fuel Dilution		<0.3				<0.3		<0.3				<0.3

Table B-18. Ft. Benning, UOA, MTV (CONT)

Control

Test	Parameter	MTV HHC-111 (153) TRANSMISSION						MTV HHC-112 TRANSMISSION					
		Miles	5328.1	5328.5	5335	5335	6344.5	*Miles*	6985.6	6986.2	6986.2	6986	6986.2
		Accum.	-	0.4	6.9	6.9	1016.4	*Accum.*	-	0.6	0.6	0.4	0.6
		Hours	-	-	-	-	-	*Hours*	-	-	-	-	-
		Accum.	-	-	-	-	-	*Accum.*	-	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*3rd QTR*	*4th QTR*
D445 100c	Viscosity		9.52	8.88	8.85	8.78	8.45		9.11	8.8	8.96	8.74	8.9
D445 40c	Viscosity		55.1				49.62		50.41				50.13
D2270	Viscosity Index		157				147		164				159
D4739	Buffer		8.43		8.26		8.52		8.94		8.26		8.02
D5185	Al		3	3	3	4	4		3	2	3	3	3
	Sb		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ba		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	B		36	34	32	34	33		53	33	28	28	28
	Ca		2752	2954	2946	2853	3022		3027	3317	3269	3196	3376
	Cr		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cu		467	532	546	550	677		332	394	399	368	422
	Fe		24	21	21	26	27		17	15	15	18	18
	Pb		2	2	2	2	2		3	4	3	3	3
	Mg		48	41	40	39	43		18	17	20	18	18
	Mn		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Mo		2	1	2	1	2		<1	<1	<1	<1	<1
	Ni		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	P		1026	1194	1164	1181	1198		1047	1290	1270	1286	1279
	Si		8	8	8	8	7		20	7	6	8	8
	Ag		<1	<1	<1	<1	<1		<1	<1	<1	<1	1
	Na		<5	7	<5	6	5		<5	5	<5	<5	<5
	Sn		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Zn		1245	1263	1282	1249	1317		1310	1369	1372	1343	1408
	K		<5	<5	<5	<5	<5		<5	5	<5	<5	<5
	Sr		1	1	<1	1	<1		1	1	1	1	1
	V		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Ti		<1	<1	<1	<1	<1		<1	<1	<1	<1	<1
	Cd		4	5	5	5	6		3	4	4	4	4
D664 Acid	Buffer		1.43		1.63		1.63		1.45		1.79		1.85
IR FTNG	Oxidation		*Did not analyze*						*Did not analyze*				
	Nitration												
D6304	Water Content		1166				1074		1245				1972
D3524	Fuel Dilution		*Not Applicable*						*Not Applicable*				

APPENDIX C.

Ft. Bliss Field Demo Raw Data

Table C-1. Ft. Bliss, Vehicle Utilization, M88A2

M88A2

	Oil Type	Bumper No.	Start of Test		1st QTR		2nd QTR		3rd QTR		4th QTR		
			Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	Mileage	Hours	
TEST	Oil A	E319	1502		1512		1828		1872		1891		Recordings
TEST	Oil A	F864	30		32		84		90		240		
CONTROL	-	E316					825				1010		
CONTROL	-	F861			323		824		830		483		

	Oil Type	Bumper No.	1st QTR	2nd QTR	3rd QTR	4th QTR	
TEST	Oil A	E319	10	316	44	19	Accumulation by Quarter
TEST	Oil A	F864	2	52	6	150	
CONTROL	-	E316				185	
CONTROL	-	F861		501	6		

	Oil Type	Bumper No.	1st QTR	2nd QTR	3rd QTR	4th QTR	
TEST	Oil A	E319	10	326	370	389	Total Accumulation
TEST	Oil A	F864	2	54	60	210	
CONTROL	-	E316				185	
CONTROL	-	F861		501	507		

Note: Reliable hr meter readings were not able to be attained

Table C-2. Ft. Bliss, Vehicle Utilization, Bradley

BRADLEY

	Oil Type	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	
TEST	**Oil A**	**A11**	3685		3699		4912		4912		4953		**Recordings**
TEST	**Oil A**	**B23**	3491		3504		4073		4073		4103		
TEST	**Oil B**	**HQ33**	1433		1445		1736		1739		1765		
TEST	**Oil B**	**B13**	2159		2177		2809		2809		5335		
CONTROL	**-**	**B21**			4132		4637				4671		
CONTROL	**-**	**B22**			3589		4057				4090		
TEST	**Oil A**	**A11**			14		1213		0		41		**Accumulation by Quarter**
TEST	**Oil A**	**B23**			13		569		0		30		
TEST	**Oil B**	**HQ33**			12		291		3		26		
TEST	**Oil B**	**B13**			18		632		0		2526		
CONTROL	**-**	**B21**					505				34		
CONTROL	**-**	**B22**					468				33		
TEST	**Oil A**	**A11**			14		1227		1227		1268		**Total Accumulation**
TEST	**Oil A**	**B23**			13		582		582		612		
TEST	**Oil B**	**HQ33**			12		303		306		332		
TEST	**Oil B**	**B13**			18		650		650		3176		
CONTROL	**-**	**B21**					505				539		
CONTROL	**-**	**B22**					468				501		

Note: Bradley mileage accumulation listed in kilometers (km), No hr meter readings

Table C-3. Ft. Bliss, Vehicle Utilization, MATV

MATV

	Oil Type	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	
TEST	Oil A	D11N	2758	1503	3117	1668	3908	2194	3910		3915	2199	Recordings
TEST	Oil A	D23	3829	846	4244	976	5035	1372	5035		5042	1375	
TEST	Oil A	D13	3903	1377	4267	1517	4671	1912	4674		4678	1916	
TEST	Oil B	D14N	2276	1368	2643	1515	3390	2025	3390		3397	2028	
TEST	Oil B	D24	2452	1146	2780	1274	3409	1912	3409		3417	1917	
TEST	Oil B	D22	2407	663	2765	787	3229	1294	3429		3437	1299	
CONTROL	-	D12			2228	924	2767	1367	2767		2774	1371	
CONTROL	-	D21N			2555	1200	3238	1703	3243		3246	1707	
TEST	Oil A	D11N			359	165	791	526	2		5	5	Accumulation by Quarter
TEST	Oil A	D23			415	130	791	396	0		7	3	
TEST	Oil A	D13			364	140	404	395	3		4	4	
TEST	Oil B	D14N			367	147	747	510	0		7	3	
TEST	Oil B	D24			328	128	629	638	0		8	5	
TEST	Oil B	D22			358	124	464	507	200		8	5	
CONTROL	-	D12					539	443	0		7	4	
CONTROL	-	D21N					683	503	5		3	4	
TEST	Oil A	D11N			359	165	1150	691	1152		1157	696	Total Accumulation
TEST	Oil A	D23			415	130	1206	526	1206		1213	529	
TEST	Oil A	D13			364	140	768	535	771		775	539	
TEST	Oil B	D14N			367	147	1114	657	1114		1121	660	
TEST	Oil B	D24			328	128	957	766	957		965	771	
TEST	Oil B	D22			358	124	822	631	1022		1030	636	
CONTROL	-	D12					539	443	539		546	447	
CONTROL	-	D21N					683	503	688		691	507	

Table C-4. Ft. Bliss, Vehicle Utilization, MAXXPRO

MAXXPRO

	Oil Type	Bumper No.	Start of Test Mileage	Start of Test Hours	1st QTR Mileage	1st QTR Hours	2nd QTR Mileage	2nd QTR Hours	3rd QTR Mileage	3rd QTR Hours	4th QTR Mileage	4th QTR Hours	
TEST	Oil A	C-107			2213		3302		3350		3350		Recordings
TEST	Oil B	HQ581	7233		7645		8027		8183		8246		
CONTROL	-	HQ582	7627		7629		7629		7674		8179		

	Oil Type	Bumper No.	1st QTR	2nd QTR	3rd QTR	4th QTR	
TEST	Oil A	C-107		1089	48	0	Accumulation by Quarter
TEST	Oil B	HQ581	412	382	156	63	
CONTROL	-	HQ582	2	0	45	505	

	Oil Type	Bumper No.	1st QTR	2nd QTR	3rd QTR	4th QTR	
TEST	Oil A	C-107		1089	1137	1137	Total Accumulation
TEST	Oil B	HQ581	412	794	950	1013	
CONTROL	-	HQ582	2	2	47	552	

Note: No hr meter readings

Table C-5. Ft. Benning, UOA, M88A1/A2

TEST					M88A2 E319					M88A2 F864				
					SCPL OIL A					SCPL OIL B				
					ENGINE					ENGINE				
					Miles	1502.1	1511.8	1828	1891.01	*Miles*	29.5	35	83.9	240
					Accum.	-	9.7	325.9	388.91	*Accum.*	-	5.5	54.4	210.5
					Hours	Non functioning				*Hours*	80.5	83	38.4	62.9
			OIL A	OIL B	*Accum.*					*Accum.*	-	2.5	-	62.9
			Fresh Oil	Fresh Oil	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
			From:C97320	From:E16801										
	D445 100c	Viscosity	8.47	8.69		9.7	9.39	10.49	8.62		9.36	9.18	9.2	9.88
	D445 40c	Viscosity				56.18		64			52.7			55.45
	D2270	Viscosity Index				158		153			162			166
	D4739	Buffer	9.49	10.44		8.38		7.29	7.5		9.15		9.53	6.94
	D5185	Al	2	4	59	16	18	96	33	5	4	4	5	8
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1
		B	14	4	4	13	13	11	14	2	4	3	3	5
		Ca	902	3563	2932	1444	1375	1695	1122	2686	3437	3097	3324	3634
		Cr	<1	<1	32	8	10	38	12	6	1	2	2	7
		Cu	<1	<1	40	10	12	31	14	13	3	4	5	12
		Fe	1	2	218	56	72	282	101	27	8	13	12	36
		Pb	<1	<1	7	2	2	6	2	2	<1	<1	<1	3
		Mg	1259	16	479	1110	1056	1219	1307	241	86	67	66	61
		Mn	<1	<1	3	<1	<1	3	1	<1	<1	<1	<1	<1
		Mo	64	8	28	58	54	72	70	2	7	7	7	10
		Ni	<1	<1	8	2	3	11	4	<1	<1	<1	<1	2
		P	1079	1129	1042	979	884	1235	1189	972	1067	951	1311	1378
		Si	5	7	116	36	40	241	79	42	15	21	26	37
		Ag	<1	<1	0	0	3	6	2	6	1	2	3	5
		Na	<5	10	32	13	10	20	17	13	11	7	9	14
		Sn	<1	<1	14	1	2	13	3	2	<1	1	<1	3
		Zn	1265	1710	1600	1383	1325	1482	1304	1404	1654	1573	1608	1706
		K	<5	8	12	5	<5	24	9	5	9	6	7	7
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	1	<1	<1	3	1	<1	<1	<1	<1	<1
		Cd	<1	<1	20	5	6	12	4	23	5	7	11	16
	D664 Acid	Buffer	1.65	2.84		2.31		3	2.15		2.68			3.23
	IR FTNG	Oxidation				-		5.04			-			1.59
		Nitration				-		0.37			-			0
	D6304	Water Content				804		589			523			584
	D3524	Fuel Dilution				-		<0.3			-			<0.3

Table C-6. Ft. Benning, UOA, M88A1/A2 (CONT)

Control		M88A2 E317 (0-1st QTR) E316 (2nd QTR on) ENGINE				M88A2 F861 ENGINE			
	Miles Accum.	N/A -	1855.5 -	825.4 -	1010 184.6	N/A -	323.3 -	N/A -	483.3 160
	Hours Accum.	- -	71.5 -	Non Functioning		- -	27.2 -	Tach Removed	
		Initial	1st QTR	2nd QTR	4th QTR	Initial	1st QTR	2nd QTR	4th QTR
D445 100c	Viscosity	Sample Not Availble		14.4	13.33	Sample Not Available	12.55	12.8	11.36
D445 40c	Viscosity			108.23	96.83		88.76		76.34
D2270	Viscosity Index			136	137		138		140
D4739	Buffer			7.15	6.37		7.65		6.6
D5185	Al		17	11	21		7	8	15
	Sb		<1	<1	<1		<1	<1	<1
	Ba		<1	<1	<1		<1	<1	<1
	B		5	3	4		3	4	4
	Ca		2254	1721	1674		2458	2566	2641
	Cr		17	14	21		3	4	6
	Cu		24	9	19		6	8	13
	Fe		100	36	69		22	28	59
	Pb		6	4	6		2	2	4
	Mg		474	733	775		230	232	257
	Mn		1	<1	1		<1	<1	<1
	Mo		25	47	53		2	2	4
	Ni		4	4	5		1	2	3
	P		940	1216	1232		930	1215	1278
	Si		75	53	73		45	55	62
	Ag		2	<1	2		2	3	3
	Na		11	11	49		10	14	26
	Sn		7	4	7		<1	1	4
	Zn		1413	1354	1343		1303	1350	1408
	K		<5	<5	<5		<5	<5	<5
	Sr		2	<1	<1		2	<1	<1
	V		<1	<1	<1		<1	<1	<1
	Ti		<1	<1	<1		<1	<1	<1
	Cd		13	5	8		4	7	9
D664 Acid	Buffer			2.55	2.73		1.74		2.19
IR FTNG	Oxidation			-	2.49		-		1.34
	Nitration			-	0		-		0
D6304	Water Content			343	559		697		728
D3524	Fuel Dilution			-	1.6		-		0.5

Table C-7. Ft. Bliss, UOA, Bradley

TEST		OIL A	OIL B	BRADLEY A11					BRADLEY B23				
				SCPL OIL A					SCPL OIL A				
				ENGINE					ENGINE				
				Miles	3685	3699	4912	4953	Miles	3491	3504	4073	4103
				Accum.	-	14	1227	1268	Accum.	-	13	582	612
				Hours	-	-	-	-	Hours	-	-	-	-
				Accum.	-	-	-	-	Accum.	-	-	-	-
		Fresh Oil From:C97320	Fresh Oil From:E16801	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
D445 100c	Viscosity	8.47	8.69		9.7	9.21	9.31	9.38		9.5	9.38	8.44	8.69
D445 40c	Viscosity				56.36			52.91		53.93			46.15
D2270	Viscosity Index				158			162		161			170
D4739	Buffer	9.49	10.44		9.06		7.32	6.85		8.52		7.88	7.06
D5185	Al	2	4	2	1	1	2	2	4	2	2	3	3
	Sb	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	4	5	14	12	11	11	4	14	12	12	12
	Ca	902	3563	1315	1017	986	993	1009	2061	1250	1209	1055	1048
	Cr	<1	<1	<1	<1	<1	4	5	6	1	2	3	3
	Cu	<1	<1	10	3	5	11	11	42	10	11	7	7
	Fe	1	2	11	4	11	32	31	45	12	14	16	17
	Pb	<1	<1	2	<1	2	7	6	9	2	2	5	4
	Mg	1259	16	816	1191	1173	1256	1275	418	1092	1050	1226	1244
	Mn	<1	<1	3	<1	2	3	3	2	<1	<1	<1	<1
	Mo	64	8	46	60	59	62	65	21	57	52	59	63
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1129	940	925	871	1105	1134	870	913	842	1102	1132
	Si	5	7	9	7	11	13	12	8	7	6	6	6
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	10	11	7	5	10	12	18	9	6	6	9
	Sn	<1	<1	<1	<1	<1	1	<1	3	<1	<1	<1	<1
	Zn	1265	1710	1323	1299	1236	1264	1256	1337	1320	1260	1254	1257
	K	<5	8	11	<5	12	20	21	22	8	5	<5	<5
	Sr	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Buffer	1.65	2.84		1.95			2.09		2.06			2.19
IR FTNG	Oxidation				-			3.08		-			2.8
	Nitration				-			0.09		-			0
D6304	Water Content				574			343		569			199
D3524	Fuel Dilution				-			0.7		-			2.8

Table C-8. Ft. Bliss, UOA, Bradley (CONT)

				BRADLEY HQ33					BRADLEY B13					
				SCPL OIL B					SCPL OIL B					
				ENGINE					ENGINE					
				Miles	1433	1445	1736	1765	*Miles*	2159	2177	2809	5335	
				Accum.	-	12	303	332	*Accum.*	-	18	650	3176	
				Hours	-	-	-	-	*Hours*	-	-	-	-	
		OIL A	OIL B	*Accum.*	-	-	-	-	*Accum.*	-	-	-	-	
TEST		Fresh Oil From:C97320	Fresh Oil From:E16801	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	
D445 100c	Viscosity	8.47	8.69		9.42	9.55	9.24	9.12		9.36	9.17	8.22	8.19	
D445 40c	Viscosity				52.98			47.18		51.6			42.87	
D2270	Viscosity Index				163			179		166			169	
D4739	Buffer	9.49	10.44		8.76		8.29	8.03		8.62		5.87	5.56	
D5185	Al	2	4	3	3	3	4	4	5	4	3	5	6	
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Ba	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	B	14	4	3	6	3	3	3	4	4	3	3	3	
	Ca	902	3563	1991	3235	3058	3252	3309	2075	3239	2732	2939	2969	
	Cr	<1	<1	4	1	2	2	2	4	1	1	3	3	
	Cu	<1	<1	40	9	9	9	7	57	13	12	27	26	
	Fe	1	2	33	9	10	14	13	42	11	12	28	28	
	Pb	<1	<1	6	<1	1	2	3	10	3	3	13	12	
	Mg	1259	16	521	132	125	108	80	428	113	199	155	131	
	Mn	<1	<1	2	<1	<1	<1	<1	2	<1	<1	<1	<1	
	Mo	64	8	26	12	12	12	11	19	11	16	14	13	
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	P	1079	1129	882	1014	964	1286	1314	877	1040	908	1145	1175	
	Si	5	7	8	7	6	6	6	13	8	6	7	8	
	Ag	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Na	<5	10	15	10	7	9	12	12	9	6	9	12	
	Sn	<1	<1	2	<1	<1	1	1	2	<1	<1	2	2	
	Zn	1265	1710	1326	1609	1555	1609	1617	1390	1618	1479	1503	1506	
	K	<5	8	9	10	8	8	8	7	10	7	7	8	
	Sr	<1	<1	<1	<1	2	1	1	<1	<1	2	<1	1	
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	
D664 Acid	Buffer	1.65	2.84		2.82			3.09		2.54			3.1	
IR FTNG	Oxidation				-			2.43		-			3.64	
	Nitration				-			0		-			0	
D6304	Water Content				486			190		614			265	
D3524	Fuel Dilution				-			0.4		-			5.4	

Table C-9. Ft. Bliss, UOA, Bradley (CONT)

					BRADLEY A11					BRADLEY B23				
					SCPL OIL A					SCPL OIL A				
					TRANSMISSION					TRANSMISSION				
					Miles	3685	3699	4912	4953	*Miles*	3491	3504	4073	4103
					Accum.	-	14	1227	1268	*Accum.*	-	13	582	612
					Hours	-	-	-	-	*Hours*	-	-	-	-
			OIL A	OIL B	*Accum.*	-	-	-	-	*Accum.*	-	-	-	-
			Fresh Oil From:C97320	Fresh Oil From:E16801	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
TEST	D445 100c	Viscosity	8.47	8.69		9.19	8.56	8.22	8.39		9.77	8.77	8.36	8.58
	D445 40c	Viscosity				51.68			45.6		47.16			47.84
	D2270	Viscosity Index				161			162		199			158
	D4739	Buffer	9.49	10.44		9.51		9.14	8.38		9.51		8.97	8.02
	D5185	Al	2	4	3	2	2	13	14	54	4	10	18	20
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	<1	<1	<1	<1	<1	2	<1	<1	<1	<1
		B	14	4	5	15	14	13	13	5	16	14	14	14
		Ca	902	3563	1466	1118	1062	1082	1072	2368	1031	1142	1166	1181
		Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cu	<1	<1	36	6	39	117	128	872	52	178	271	305
		Fe	1	2	9	3	4	31	34	62	5	12	22	25
		Pb	<1	<1	4	<1	6	11	13	11	<1	2	4	5
		Mg	1259	16	726	1195	1188	1252	1240	70	1249	1082	1119	1119
		Mn	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1
		Mo	64	8	42	61	58	61	63	2	63	55	54	56
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1129	967	941	868	1145	1171	983	970	888	1134	1162
		Si	5	7	11	7	7	11	12	48	8	14	19	18
		Ag	<1	<1	<1	<1	<1	<1	1	2	<1	<1	1	1
		Na	<5	10	8	6	<5	6	10	15	6	5	7	10
		Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Zn	1265	1710	1317	1312	1230	1252	1253	1151	1287	1229	1240	1234
		K	<5	8	6	<5	6	6	8	<5	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	1	<1	<1	<1	<1	2	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	6	<1	5	22	27	20	1	6	18	22
	D664 Acid	Buffer	1.65	2.84		1.93			1.76		1.87			1.75
	IR FTNG	Oxidation				-			0.28		-			0.28
		Nitration				-			0		-			0
	D6304	Water Content				601			418		341			372
	D3524	Fuel Dilution							-		-			-

Table C-10. Ft. Bliss, UOA, Bradley (CONT)

TEST		OIL A	OIL B	BRADLEY HQ33 SCPL OIL B TRANSMISSION					BRADLEY B13 SCPL OIL B TRANSMISSION				
				Miles	1433	1445	1736	1765	*Miles*	2159	2177	2809	5335
				Accum.	-	12	303	332	*Accum.*	-	18	650	3176
				Hours	-	-	-	-	*Hours*	-	-	-	-
				Accum.	-	-	-	-	*Accum.*	-	-	-	-
		Fresh Oil From:C97320	Fresh Oil From:E16801	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
D445 100c	Viscosity	8.47	8.69		8.96	9.06	9.02	8.72		8.79	8.84	8.64	9.05
D445 40c	Viscosity				48.02			50.02		47.07			47.32
D2270	Viscosity Index				170			154		169			176
D4739	Buffer	9.49	10.44		9.44		9.45	8.57		9.52		9.59	8.6
D5185	Al	2	4	27	6	8	12	12	19	5	6	13	13
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	B	14	4	2	5	4	4	3	4	4	4	3	5
	Ca	902	3563	2738	3395	3130	3338	3304	2648	3504	3237	3418	3273
	Cr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cu	<1	<1	644	81	129	145	156	745	63	136	266	289
	Fe	1	2	38	7	10	13	15	44	6	8	16	18
	Pb	<1	<1	40	5	10	14	16	21	2	5	13	18
	Mg	1259	16	135	37	48	48	47	206	29	41	38	36
	Mn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Mo	64	8	7	8	8	8	9	1	7	7	7	7
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1129	996	1045	1003	1304	1319	1051	1038	1030	1319	1286
	Si	5	7	49	12	13	15	15	27	8	8	10	10
	Ag	<1	<1	1	<1	<1	<1	<1	2	<1	<1	<1	<1
	Na	<5	10	19	11	11	10	13	9	9	8	9	8
	Sn	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1710	1234	1662	1546	1576	1560	1253	1677	1575	1596	1560
	K	<5	8	29	13	11	13	13	5	10	5	6	6
	Sr	<1	<1	<1	<1	<1	1	1	<1	<1	<1	1	<1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	35	4	8	11	12	38	3	8	16	18
D664 Acid	Buffer	1.65	2.84		2.6			2.53		2.41			2.15
IR FTNG	Oxidation				-			0.09		-			0.56
	Nitration				-			0		-			0
D6304	Water Content				584			311		589			444
D3524	Fuel Dilution				-			-		-			-

Table C-11. Ft. Bliss, UOA, Bradley (CONT)

Control

		BRADLEY B21 ENGINE					BRADLEY B22 ENGINE				
		Miles	N/A	4132	4637	4671	*Miles*	N/A	3589	4057	4090
		Accum.	-	-	505	539	*Accum.*	-	-	468	501
		Hours	-	-	-	-	*Hours*	-	-	-	-
		Accum.	-	-	-	-	*Accum.*	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
D445 100c	Viscosity		Sample Not Availble	13.9	13.43	13.42		Sample Not Availble	12.65	14.5	13.75
D445 40c	Viscosity			102.89							
D2270	Viscosity Index			136							
D4739	Buffer			6.33							
D5185	Al			3	4	4			4	2	2
	Sb			1	1	2			<1	<1	<1
	Ba			2	2	2			<1	<1	<1
	B			4	4	4			2	3	4
	Ca			1280	1376	1371			2161	1471	1471
	Cr			2	4	4			6	2	2
	Cu			13	19	23			30	7	8
	Fe			25	41	45			75	24	24
	Pb			5	9	10			17	4	5
	Mg			759	808	758			248	757	703
	Mn			4	5	5			3	<1	<1
	Mo			45	47	45			11	42	40
	Ni			<1	<1	<1			<1	<1	<1
	P			873	1109	1089			754	1151	1129
	Si			17	20	20			11	7	5
	Ag			<1	<1	<1			<1	<1	<1
	Na			14	17	18			14	7	8
	Sn			<1	2	3			5	<1	1
	Zn			1269	1286	1279			1189	1290	1273
	K			8	12	13			5	<5	<5
	Sr			<1	<1	<1			<1	<1	<1
	V			<1	<1	<1			<1	<1	<1
	Ti			<1	<1	<1			<1	<1	<1
	Cd			<1	<1	<1			<1	<1	<1
D664 Acid	Buffer			2.43		2.46					
IR FTNG	Oxidation			-		2.85					
	Nitration			-		0					
D6304	Water Content			343		217					
D3524	Fuel Dilution			-		<0.3					

Table C-12. Ft. Bliss, UOA, Bradley (CONT)

Control

			BRADLEY B21					BRADLEY B22			
		TRANSMISSION					TRANSMISSION				
		Miles	N/A	4132	4637	4671	*Miles*	N/A	3589	4057	4090
		Accum.	-	-	505	539	*Accum.*	-	-	468	501
		Hours	-	-	-	-	*Hours*	-	-	-	-
		Accum.	-	-	-	-	*Accum.*	-	-	-	-
			Initial	*1st QTR*	*2nd QTR*	*4th QTR*		*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
D445 100c	Viscosity		Sample Not Availble	10.58	10.73	10.72		Sample Not Availble	12.67	11.99	11.99
D445 40c	Viscosity			76.48		76.4			93.56		87.22
D2270	Viscosity Index			124		127			131		130
D4739	Buffer			6.12		5.76			7.63		7.3
D5185	Al			39	42	42			7	14	14
	Sb			<1	<1	<1			<1	<1	<1
	Ba			1	1	1			5	5	5
	B			2	2	2			2	2	3
	Ca			2592	2592	2705			1823	1915	1937
	Cr			<1	<1	<1			<1	<1	<1
	Cu			712	738	806			138	230	248
	Fe			59	60	68			17	28	32
	Pb			28	28	29			6	8	8
	Mg			87	128	130			492	494	527
	Mn			1	1	1			<1	<1	<1
	Mo			4	6	6			25	25	26
	Ni			<1	<1	<1			<1	<1	<1
	P			991	1118	1133			953	1196	1193
	Si			54	57	57			9	12	12
	Ag			2	2	2			<1	<1	<1
	Na			22	20	22			6	7	7
	Sn			<1	<1	<1			<1	<1	<1
	Zn			1155	1173	1172			1352	1386	1380
	K			43	41	42			<5	<5	<5
	Sr			<1	<1	<1			<1	<1	<1
	V			<1	<1	<1			<1	<1	<1
	Ti			<1	<1	<1			<1	<1	<1
	Cd			28	27	28			11	18	20
D664 Acid	Buffer			1.53		1.55			1.88		1.92
IR FTNG	Oxidation			-		0.3			-		0.15
	Nitration			-		0			-		0
D6304	Water Content			329		270			340		254
D3524	Fuel Dilution			-		-			-		-

Table C-13. Ft. Benning, UOA, MATV

					MATV D11N					MATV D23					MATV D13				
					SCPL OIL A					SCPL OIL A					SCPL OIL A				
					ENGINE					ENGINE					ENGINE				
					Miles	2757.5	3117.3	3907.8	3914.8	Miles	3828.8	4243.7	5035	5042.3	Miles	3902.7	4266.5	4671.2	4677.9
					Accum.	-	359.8	1150.3	1157.3	Accum.	-	414.9	1206.2	1213.5	Accum.	-	363.8	1913.7	1920.4
					Hours	1502.7	1667.9	2193.6	2199.3	Hours	845.6	975.7	1372.1	1375.4	Hours	1377.1	1516.5	1911.7	1916.3
			OIL A	OIL B	Accum.	-	165.2	690.9	696.6	Accum.	-	130.1	526.5	529.8	Accum.	-	139.4	534.6	539.2
			Fresh Oil From:C97320	Fresh Oil From:E16801	As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR
TEST	D445 100c	Viscosity	8.47	8.69		8.95	8.76	8.87	9.08		8.93	8.94	8.79	9.05		9.26	9.15	9.13	9.28
	D445 40c	Viscosity				49.59			51.14		49.59			50.34		49.99			52.37
	D2270	Viscosity Index				163			160		162			162		170			161
	D4739	Buffer	9.49	10.44		8.69		6.67	6.13		8.92		7.61	6.81		9		7.23	6.3
	D5185	Al	2	4	4	2	2	4	4	6	2	2	3	3	4	2	3	4	4
		Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ba	<1	<1	4	<1	<1	<1	<1	3	<1	<1	<1	<1	3	<1	<1	<1	<1
		B	14	4	1	16	13	9	10	1	14	13	10	10	15	16	14	11	11
		Ca	902	3563	2868	1225	1196	1285	1292	3049	1226	1217	1242	1206	2715	1171	1173	1265	1254
		Cr	<1	<1	3	<1	1	2	2	3	<1	<1	2	1	3	<1	1	2	2
		Cu	<1	<1	608	86	140	162	169	673	97	143	174	175	372	48	86	108	111
		Fe	1	2	63	10	18	38	39	68	11	18	27	28	47	8	15	28	30
		Pb	<1	<1	2	<1	<1	1	1	2	<1	<1	1	<1	1	<1	<1	1	1
		Mg	1259	16	113	1170	1085	1162	1162	62	1142	1085	1195	1178	405	1215	1138	1213	1212
		Mn	<1	<1	2	<1	<1	<1	<1	2	<1	<1	<1	<1	1	<1	<1	<1	<1
		Mo	64	8	1	58	55	57	58	<1	56	54	58	59	26	61	58	61	62
		Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		P	1079	1129	970	955	894	1074	1111	952	918	895	1106	1121	1046	995	916	1107	1137
		Si	5	7	18	8	9	12	11	15	7	10	10	9	14	7	9	10	10
		Ag	<1	<1	1	<1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Na	<5	10	8	6	7	6	9	8	6	6	5	8	6	7	6	5	7
		Sn	<1	<1	2	<1	<1	<1	<1	3	<1	<1	<1	<1	2	<1	<1	<1	<1
		Zn	1265	1710	1399	1319	1279	1320	1317	1338	1310	1257	1292	1280	1477	1331	1283	1323	1317
		K	<5	8	7	<5	<5	<5	<5	7	<5	<5	<5	<5	6	<5	<5	<5	<5
		Sr	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	D664 Acid	Buffer	1.65	2.84		1.84			3.01		2.06			2.54		2.03			3.08
	IR FTNG	Oxidation				-			4.58		-			2.87		-			4.01
		Nitration				-			0.19		-			0		-			0
	D6304	Water Content				630			434		514			503		576			721
	D3524	Fuel Dilution				-			<0.3		-			<0.3		-			<0.3

Table C-14. Ft. Benning, UOA, MATV (CONT)

TEST					MATV D14N					MATV D24					MATV D22			
					SCPL OIL B					SCPL OIL B					SCPL OIL B			
					ENGINE					ENGINE					ENGINE			
				Miles	2275.5	2643.4	3390	3396.5	*Miles*	2452.2	2779.9	3409.1	3417	*Miles*	2406.8	2764.7	3428.8	3436.6
				Accum.	-	367.9	632.5	639	*Accum.*	-	327.7	651.6	659.5	*Accum.*	-	357.9	671.3	679.1
				Hours	1367.7	1514.7	2024.9	2027.9	*Hours*	1146.2	1273.5	1911.9	1916.7	*Hours*	662.8	787.2	1294.1	1299.1
		OIL A	OIL B	*Accum.*	-	147	657.2	660.2	*Accum.*	-	127.3	765.7	770.5	*Accum.*	-	124.4	631.3	636.3
		Fresh Oil From:C97320	Fresh Oil From:E16801	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*	*As found*	*Initial*	*1st QTR*	*2nd QTR*	*4th QTR*
D445 100c	Viscosity	8.47	8.69		8.92	8.57	8.62	8.72		8.93	8.7	8.4	8.66		9	8.69	8.31	8.6
D445 40c	Viscosity				47.08			47.95		48.29			46.98		48.41			46.83
D2270	Viscosity Index				173			162		168			165		169			164
D4739	Buffer	9.49	10.44		9.45		6.76	5.69		9.12		7.16	6.05		8.97		7.12	6.16
D5185	Al	2	4	2	3	4	7	7	4	4	4	4	4	3	4	4	7	7
	Sb	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	2	<1	<1	<1	<1	2	<1	<1	<1	<1	3	<1	<1	<1	<1
	B	14	4	2	4	3	2	3	2	4	3	2	4	2	4	4	2	3
	Ca	902	3563	2732	3525	3321	3438	3432	3053	3455	3310	3545	3569	2971	3522	3311	3552	3503
	Cr	<1	<1	2	<1	<1	2	2	3	<1	1	2	2	3	<1	<1	2	2
	Cu	<1	<1	536	37	109	129	133	603	74	98	98	103	544	72	96	102	107
	Fe	1	2	32	4	10	20	21	43	7	11	18	20	44	8	12	22	23
	Pb	<1	<1	1	<1	<1	1	1	2	<1	<1	<1	<1	2	<1	<1	1	<1
	Mg	1259	16	166	22	35	35	33	52	17	17	16	18	93	31	23	22	21
	Mn	<1	<1	1	<1	<1	<1	<1	1	<1	<1	<1	<1	2	<1	<1	<1	<1
	Mo	64	8	1	8	7	7	8	<1	7	7	8	8	1	7	7	8	8
	Ni	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1129	1007	1051	1034	1262	1274	961	1065	1005	1255	1305	991	1098	1012	1266	1291
	Si	5	7	12	7	7	9	8	34	10	16	18	17	15	8	8	8	8
	Ag	<1	<1	<1	<1	<1	<1	<1	1	<1	<1	<1	<1	1	<1	<1	<1	<1
	Na	<5	10	8	10	8	8	10	10	10	8	8	11	10	9	9	8	11
	Sn	<1	<1	<1	<1	<1	1	1	2	<1	<1	1	1	2	<1	<1	1	1
	Zn	1265	1710	1409	1705	1611	1658	1620	1355	1679	1601	1648	1661	1370	1672	1611	1659	1642
	K	<5	8	5	11	7	7	8	8	10	6	8	8	8	10	7	8	8
	Sr	<1	<1	<1	<1	<1	1	1	<1	<1	<1	1	1	<1	<1	2	1	1
	V	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Buffer	1.65	2.84		2.88			3.05		2.5			2.77		2.91			3.1
IR FTNG	Oxidation				-			2.24		-			2.89		-			2.71
	Nitration				-			0.19		-			0		-			0
D6304	Water Content				512			442		558			304		589			258
D3524	Fuel Dilution				-			<0.3		-			<0.3		-			<0.3

Table C-15. Ft. Benning, UOA, MATV (CONT)

Control

		MATV D12 ENGINE				MATV D21N ENGINE			
	Miles	N/A	2227.8	2766.7	2773.6	N/A	2554.9	3238.1	3245.7
	Accum.	-	-	538.9	545.8	-	-	683.2	690.8
	Hours	N/A	924.3	1366.8	1371.2	N/A	1200.2	1702.5	1706.6
	Accum.	-	-	442.5	446.9	-	-	502.3	506.4
		Initial	1st QTR	2nd QTR	4th QTR	Initial	1st QTR	2nd QTR	4th QTR
D445 100c	Viscosity	Unit Not On Test Until 1st QTR	11.96	11.97	12.05	Unit Not On Test Until 1st QTR	12.1	12.14	12.2
D445 40c	Viscosity		85.96		87.18		87.24		89.27
D2270	Viscosity Index		132		132		132		131
D4739	Buffer		4.25		2.72		3.61		2.58
D5185	Al		2	2	2		3	4	4
	Sb		<1	<1	<1		<1	<1	<1
	Ba		2	2	2		3	3	3
	B		3	3	2		2	2	2
	Ca		2777	2758	2848		2706	2851	2822
	Cr		3	3	3		3	3	3
	Cu		697	591	633		513	501	507
	Fe		32	42	43		52	66	69
	Pb		2	2	<1		2	2	2
	Mg		126	122	119		137	132	128
	Mn		2	2	2		2	2	2
	Mo		1	1	2		1	1	1
	Ni		<1	<1	<1		<1	<1	<1
	P		1012	1094	1148		961	1108	1146
	Si		18	17	17		16	17	16
	Ag		1	1	1		<1	<1	<1
	Na		8	7	9		9	8	10
	Sn		2	2	2		2	2	2
	Zn		1335	1359	1356		1345	1381	1362
	K		<5	<5	6		<5	5	5
	Sr		2	<1	1		2	<1	1
	V		<1	<1	<1		<1	<1	<1
	Ti		<1	<1	<1		<1	<1	<1
	Cd		<1	<1	<1		<1	<1	<1
D664 Acid	Buffer		2.48		3.02		2.9		3.7
IR FTNG	Oxidation		-		2.61		-		3.32
	Nitration		-		0		-		1.12
D6304	Water Content		412		385		506		420
D3524	Fuel Dilution		-		<0.3		-		<0.3

Table C-16. Ft. Benning, UOA, MAXXPRO

TEST				MAXXPRO C107					MAXXPRO HQ581				
				SCPL OIL A					SCPL OIL B				
				ENGINE					ENGINE				
				Miles	N/A	2113	3302	3350	Miles	7233	7645	8027	8246
				Accum.	-	-	1189	1237	Accum.	-	412	794	1013
				Hours	-	-	-	-	Hours	-	-	-	-
		OIL A	OIL B	Accum.	-	-	-	-	Accum.	-	-	-	-
		Fresh Oil From:C97320	Fresh Oil From:E16801	As found	Initial	1st QTR	2nd QTR	4th QTR	As found	Initial	1st QTR	2nd QTR	4th QTR
D445 100c	Viscosity	8.47	8.69		Unit Not On Test Until 1st QTR	8.58	7.7	7.75		8.93	8.11	7.94	7.7
D445 40c	Viscosity					47.43		39.87		48.94			40.52
D2270	Viscosity Index					160		168		165			163
D4739	Buffer	9.49	10.44			8.24	7.1	6.17		8.61		7.53	6.23
D5185	Al	2	4	2		1	1	1	1	3	3	3	3
	Sb	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ba	<1	<1	3		<1	<1	<1	<1	<1	<1	<1	<1
	B	14	4	24		18	14	13	3	3	3	3	3
	Ca	902	3563	2190		1093	1104	1101	2237	3379	3073	3247	3136
	Cr	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Cu	<1	<1	41		7	10	12	9	2	2	4	5
	Fe	1	2	36		7	20	22	24	7	8	12	18
	Pb	<1	<1	7		1	2	2	2	<1	<1	2	2
	Mg	1259	16	8		1074	1085	1017	165	47	42	42	42
	Mn	<1	<1	4		<1	1	1	1	<1	<1	<1	<1
	Mo	64	8	<1		54	54	52	2	7	7	7	7
	Ni	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	P	1079	1129	704		831	1048	1031	852	1051	926	1247	1194
	Si	5	7	16		7	7	6	4	6	4	5	5
	Ag	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Na	<5	10	10		<5	6	<5	6	9	<5	7	<5
	Sn	<1	<1	2		<1	<1	<1	<1	<1	<1	<1	<1
	Zn	1265	1710	1110		1223	1204	1191	1252	1643	1552	1576	1510
	K	<5	8	15		<5	<5	<5	<5	10	6	6	5
	Sr	<1	<1	2		2	<1	<1	<1	<1	2	1	<1
	V	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Ti	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
	Cd	<1	<1	<1		<1	<1	<1	<1	<1	<1	<1	<1
D664 Acid	Buffer	1.65	2.84			1.97		2.4		2.71			2.72
IR FTNG	Oxidation					-		3.45		-			1.21
	Nitration					-		0.19		-			0.09
D6304	Water Content					485		297		466			472
D3524	Fuel Dilution					-		4.2		-			3.3

Table C-17. Ft. Benning, UOA, MAXXPRO (CONT)

			MAXPRO HQ582				
			ENGINE				
			Miles	7627	7629	7629	8179
			Accum.	-	2	2	552
			Hours	-	-	-	-
			Accum.	-	-	-	-
				Initial	1st QTR	2nd QTR	4th QTR
Control	D445 100c	Viscosity		10.02	10.24	10.3	10.2
	D445 40c	Viscosity		67.29			68.29
	D2270	Viscosity Index		133			134
	D4739	Buffer		3.77			3.11
	D5185	Al		<1	1	<1	<1
		Sb		<1	<1	<1	<1
		Ba		<1	<1	<1	<1
		B		2	2	2	2
		Ca		2171	2021	2142	2208
		Cr		<1	<1	<1	<1
		Cu		9	8	8	9
		Fe		21	19	19	27
		Pb		2	1	2	2
		Mg		112	124	122	127
		Mn		<1	<1	<1	1
		Mo		2	2	2	2
		Ni		<1	<1	<1	<1
		P		823	774	1035	1036
		Si		4	4	3	4
		Ag		<1	<1	<1	<1
		Na		5	<5	<5	<5
		Sn		<1	<1	<1	<1
		Zn		1190	1151	1183	1190
		K		<5	<5	<5	<5
		Sr		<1	2	<1	<1
		V		<1	<1	<1	<1
		Ti		<1	<1	<1	<1
		Cd		<1	<1	<1	<1
	D664 Acid	Buffer		2.13			2.33
	IR FTNG	Oxidation		-			1.57
		Nitration		-			0
	D6304	Water Content		841			161
	D3524	Fuel Dilution		-			<0.3